# FOREST ECOSYSTEM CLASSIFICATION OF THE TURKEY LAKES WATERSHED, ONTARIO



*ECS Acid Precipitation Research*
**Ecological Land Classification Series No. 18**



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Canada

# FOREST ECOSYSTEM CLASSIFICATION OF THE TURKEY LAKES WATERSHED, ONTARIO

A Research Contribution From The Federal LRTAP Calibrated Watersheds Program

by
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edited by
L.K.Li

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Cover Photo: Westward looking vista of the Turkey Lakes Watershed from Batchawana Mountain. Photograph by G.M. Wickware.

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# PREFACE

This report has been prepared by the Lands Directorate in cooperation with the Canadian Forestry Service, recognizing the contribution and shared interest of our colleagues in ecological land classification and acid precipitation research on forest ecosystems. The Turkey Lakes watershed study is part of a multi-year effort, within the federal Long Range Transport of Air Pollutants (LRTAP) Program to study the long-term effects of acidic deposition on forested ecosystems. Forest sites in the Turkey Lakes Watershed, Algoma District, north-central Ontario, were classified into 17 major vegetation types and 9 major soil types. Subsequent ordination of the vegetation and soil types suggested that complex environmental gradients relating to elevation, slope position, soil texture, and soil nutrients are present. Recognizing the importance of vegetation in modifying incident precipitation, both overstory and understory plant species were used in classifying the vegetation. Soil classification considered variables such as texture and thickness, type of mineral, and organic horizons which are known to influence soil pH and acidity, mobile anion availability, base leaching, cation availability, and exchange capacity. Vegetation and soil types were related to major site variables such as slope, aspect, exposure and elevation which are also known to have potential effects relating to rainfall intensity and distribution as well as groundwater modification. Finally, nine soil and vegetation types were mapped as recurring combinations throughout the watershed at a scale of 1:12 000 This is providing a comprehensive data base and holistic framework for several related LRTAP interdisciplinary studies in the Turkey Lakes watershed.

TYPICAL FOREST COMMUNITY ALONG ONE OF THE STREAMS IN THE TURKEY LAKES WATERSHED.

## 1.0 INTRODUCTION

Concern for the fate and impact of acidic deposition on relatively undisturbed terrestrial and aquatic ecosystems led to the establishment, in 1980, of a five-year research program in the Turkey Lakes watershed, Algoma District, north-central Ontario. The program involves intensive chemical, hydrological, and biological studies on 5 lakes and 20 sub-watersheds within the main study area. Included in these intensive investigations is the monitoring of precipitation, air quality, forest effects, ground and soil water, and stream and lake chemistry.

Because of the complex interactions between the incident precipitation and the various components of the forest ecosystem, it has been recognized that in order to understand the long-term effects of acidic deposition on forest ecosystems it would be necessary to define these ecosystems in terms of their existing vegetation, soil, and site characteristics. This study, initiated during the summer of 1980 as part of the larger research program, set out to define the major forest vegetation and soil types in the watershed, their relationship to each other and to various site factors. Once established, these types and relationships could then be used as a general framework within which other on-going research in the watershed might be interpreted on an ecosystem basis.

Vegetation is the primary recipient of most airborne pollutants. Considerable $Ca^{2+}$, $Mg^{2+}$, and $SO_4{}^{2-}$ enrichment of incident precipitation occurs as the precipitation filters through hardwood forest stands with well-developed canopy, understory and litter layers, before entering the soil profile (Lee and Weber, 1980; and Eaton et al., 1973). Since both the overstory and understory vegetation significantly affect the chemical composition of incident precipitation both are used in defining the major vegetation types in the watershed. Understory vegetation, in particular the presence and abundance of herb and shrub species, is an important factor in evaluating the nutrient cycling of forest stands (Tappeiner and Alan, 1975). Most significant is the increase in total litter added annually to the forest floor and the differing chemical compositions of the litter fall from that of the overstory vegetation of the forest (Scott, 1955; Ovington, 1955; Tappeiner and Alan, 1975; and Perala and Alban, 1982).

In defining the major soil types of the watershed, variables such as texture, thickness and type of mineral and organic horizons which are known to influence soil acidity, mobile anion availability, base leaching, cation availability and exchange capacity (Memorandum of Intent, 1983) were analyzed (Cowell and Wickware, 1983).

Site variables such as slope, aspect, exposure and elevation, which also have potential effects on rainfall intensity and distribution as well as the groundwater regime, are considered in relationship to the occurrence of the various vegetation and soil types of the watershed.

A final objective of the program is to map recurring patterns or combinations of the soil and vegetation types throughout the watershed. These recurring combinations or "map unit types" may be subsequently evaluated using the criteria developed by Lucas and Cowell (1982) for relative sensitivity to acidic deposition.

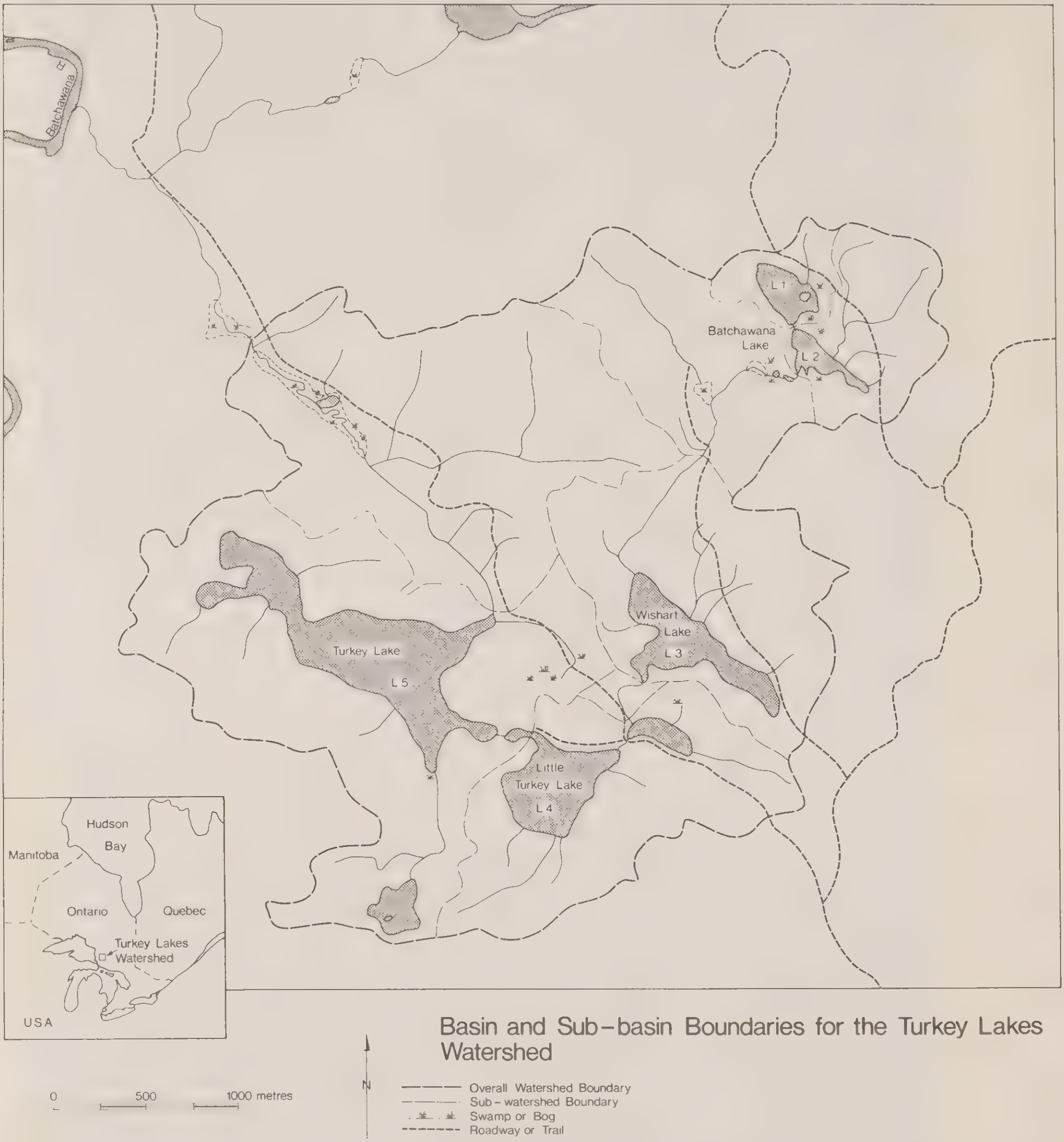
## 2.0 DESCRIPTION OF STUDY AREA

The watershed, which covers a total of 1090 ha, is located 60 km to the north of Sault Ste. Marie, Ontario at 47°03'00"N latitude and 84°25'00"W longitude (Figure 1). The area is a strongly broken upland on the Canadian Shield with a series of east-west ridges. Relief in the watershed is approximately 275 m. The highest point, indeed one of the highest points in the entire Algoma district as well as Ontario, is Batchawana Mountain at 630 m a.s.l.

Mean annual daily temperature in the watershed is 3.3°C with a July mean daily temperature of 16.6-17.7°C and mean daily January temperature of -10°C (Chapman and Thomas, 1968). Mean annual precipitation at Montreal Falls (elevation 408 m) is 1123 mm (Jeffries and Semkin, 1982).

Bedrock in the watershed is Precambrian in origin and consists of felsic, igneous, and metamorphic rocks (mainly granodiorite, quartz diorite, granite, quartz and feldspar porphyries). Early Precambrian metavolcanics consisting of ophiolite, basalt, andesite, and minor amounts of other intrusives also occur in the watershed (Ontario Geological Survey, 1970). Mineralogical analyses (Kusmirsky and Cowell, 1983) have shown the granitic material to have a high feldspathic content ($>50\%$).

The area was overridden during the Wisconsin glaciation by continental ice sheets.




Basin and Sub-basin Boundaries for the Turkey Lakes Watershed

**FIGURE 1.**

TABLE 1. BASIN AND SUB-BASIN AREAS FOR THE TURKEY LAKES WATERSHED. (SOURCE: JEFFRIES AND SEMKIN, 1982, p.7).

| Basin[1] | Total Area[2] (ha) | Lake Area (ha) | Ratio[3] | Terrestrial Area[4] (ha) |
|---|---|---|---|---|
| Batchawana L. (North) | 24.0 | 5.88 | 0.245 | 18.1 |
| Batchawana L. (South) | 61.7 | 5.82 | 0.0943 | 55.9 |
| Batchawana L. (Whole) | 85.6 | 11.7 | 0.137 | 73.9 |
| Basin above S1 | 185 | – | – | 173 |
| Wishart Lake[5] | 337 | 19.2 | 0.0570 | 306 |
| Little Turkey Lake | 491 | 19.2 | 0.0391 | 441 |
| Turkey Lake | 803 | 52.0 | 0.0648 | 701 |
| Basin above S5 | 1050 | – | – | 948 |

[1]Basin for a lake includes all terrestrial and aquatic terrain above the outflow of the lake.

[2]Includes lake area.

[3]Ratio - Lake Area/Total Area.

[4]Terrestrial Area = Total Area $-\sum$(Lake Areas).

[5]Area above S2 = 344 ha, e.g. 2.1% greater than area above Wishart Lake outflow.

Following their withdrawal approximately 11,500 years B.P. (Prest, 1970), the area was left blanketed by a ground moraine of silty to sandy till with large amounts of stones, boulders and gravel. A compact, stony, basal till underlies the surface till throughout the watershed. Locally, small pockets of stratified ice-contact deposits are found. The sediments are low in base saturation.

Soils of the watershed are predominantly well-developed Orthic Humo-Ferric Podzols. Scattered pockets of highly humified organic deposits are found at all elevations in bedrock-controlled depressions and adjacent to lakes and streams.

Although the watershed lies within the Great Lakes-St. Lawrence Lowland Forest Region, Algoma Section (Rowe, 1972) or within the Laurentian Upland Section of the Hemlock-White Pine-Northern Hardwood Region (Braun, 1950), the area is very much an extension of the Boreal Forest Region immediately to the north. Boreal herb species such as *Trientalis borealis* Raf., *Coptis trifolia* (L.) Salisb., *Clintonia borealis* (Ait.) Raf., *Linnaea borealis* L. and *Cornus canadensis* L. are common on north and west facing sites or sites influenced by cold air drainage. Sugar Maple (*Acer saccharum* Marsh.) and Yellow Birch (*Betula lutea* Michx. f.) dominate most upland sites in the watershed, with White Spruce (*Picea glauca* Moench Voss.) and White Pine (*Pinus strobus* L.) being locally dominant in the forest canopy on upland mineral soil sites. Eastern White Cedar (*Thuja occidentalis* L.), Red Oak (*Quercus rubra* L.), and Ironwood (*Ostrya virginiana* [Mill.] K. Koch.) are occasionally important as secondary canopy species. Tamarack (*Larix laricina* [DuRoi] K. Koch.), Black Ash (*Fraxinus nigra* Marsh.), Sugar Maple,

Eastern White Cedar and Red Maple (*Acer rubrum* L.) occur as dominants on wet sites.

The watershed has a number of lakes and ponds, the largest being Turkey Lake approximately 52 ha in area. Drainage from the watershed is to the Batchawana River which flows westward from the area and empties into Lake Superior, approximately 20 km from the watershed. Details on the morphometry of lakes in the watershed are summarized in Table 1.

## 3.0 METHODS

### 3.1 Field Methods: Stand Data Collection

Field sampling was similar to the reconnaissance technique described by Franklin et al (1970). Stands were subjectively sampled along extended traverses, up and down the slopes in the watershed. Particular attention was paid in selecting the transect lines to ensure representation of the various slopes, aspect, microtopographic, and elevational conditions encountered. Along each transect, sampling was done where major changes in community structure and composition occurred. At the same time, sampling was carried out without any preconceived concept of community types. Selection of each stand was therefore based on apparent uniformity in vegetation, environmental and soil conditions, as well as lack of obvious human influences such as logging activity. All stands were relatively mature; tree canopies and understory species had reached some apparent level of stability. Stand ages were estimated (tree cores at breast height) to be between 115-160 years old.

Thirty, 10 m x 10 m square plots were established and marked using nylon cord strung around the perimeters. Each plot was examined for species complement. Species[1] were recorded on a standard field data collection form by height, stratum and percent cover. Heights were recorded using a Hagar altimeter. Percent cover was visually estimated using the following scale: x = one or a few individuals, P = 1-5%, 1 = 5-15%, 2 = 15-25%, 3 = 25-35% .... 9 = 85%+. General mensurational data including height, age and dbh were also recorded for 3 replicates of each dominant tree species in each plot. Twenty 2 m x 2 m plots were placed around the outside perimeter of each of the 10 m x 10 m plots for regeneration analysis. Data were recorded according to species, number of stems and height class (0-10 cm; 10-50 cm; 50-200 cm; 200 cm with dbh 2.5 cm; saplings 200 cm with dbh 2.5-100 cm; and saplings 200+ cm with dbh 2.5-100 cm).

Within each 10 m x 10 m plot, a 1 m x 1 m soil pit was dug to a maximum depth of 1 m or 25 cm into what was interpreted in the field as a C horizon. Extreme stoniness and the compact basal till underlying the surface till sometimes limited the depth of excavation.

Many of the lowest horizons identified in the field as C horizons were later designated as BC or BM horizons on the basis of organic carbon contents of .4 to 1.2% and pyrophosphate-extractable Fe and Al of .1 to .2% and .3 to .5%, respectively. The field identification of the C horizon in these podzolic soils is known to present a problem (Evans, 1982).

Detailed soil profile descriptions were made for 29 of the 30 plots, including horizon thickness, depth, colour, coarse fragment (volume and size) texture and rooting depth and zones. Bulk samples were taken from each horizon for laboratory analyses. A report and quantitative analysis of this data for 12 sites are presented in Cowell and Wickware (1983). Forest humus class was recorded at each pit and at five randomly chosen locations throughout each plot. Soil moisture was estimated using the Ontario Institute of Pedology (1980) physiographic system for estimating pore pattern and soil moisture regime on deep and organic soils where present. Classification of the forest humus form is based on Bernier (1968). General site characteristics including slope, elevation, slope position, aspect, landform, seepage conditions and microtopography were also noted at each stand.

In addition to these 30 intensively sampled plots, 50, 10 m x 10 m plots were established in which basic vegetation information including species complement, height, stratum, and percent cover was collected. Therefore, in establishing the classification, a total of 80 plots were available for vegetation analysis and 29 for soil analysis.

During the mapping phase of the project an additional 420 stands were classified by their soil and vegetation types using the classification keys developed from the previously collected and analysed detailed stand data. This additional information enabled us to critically evaluate the previously devel-

[1] Nomenclature for vascular plants follows Gleason and Cronquist (1983), Ireland and Cain (1975) for the mosses, and Hale and Culberson (1970) for the lichens.

oped vegetation and soil types and to make modifications where necessary, and to describe a number of new soil and vegetation types, not previously encountered. Further, this substantial data base was also used to analyze the correlation of the various soil types and vegetation types with other site and environmental factors.

### 3.2 Laboratory Methods and Quantitative Procedures

#### 3.2.1 Classification and Ordination Analyses

The vegetation (80 sites) and soil (29 sites) data which were collected in the initial field sampling phase of the project were analysed using two of the Cornell Ecology Programs, TWINSPAN (Hill, 1979a) and DECORANA (Hill, 1979b).

TWINSPAN is a two-way, polythetic divisive classification program in which two parameters, species and stands, are both classified. The program facilitates the identification of characteristic associations of (1) vegetation species - vegetation types, and (2) soil attributes - soil types. Vegetation types are named according to the diagnostic tree and herb species. Soil types are named according to their diagnostic surface and subsurface textures. In addition, TWINSPAN generates the information necessary to construct a classification dendrogram or "key". Such keys enable the user to objectively and efficiently classify other stands which were not used in the development of the classification. This feature was particularly useful during the mapping phase of this study when an additional 420 stands in the watershed were sampled in the field to determine their soils and vegetation type.

DECORANA is an ordination program which uses Detrended Correspondence Analysis. The program helps to highlight relative similarities and differences within the major vegetation types and soil types. In interpreting the results, an attempt was made to infer significant environmental gradients to explain the distribution of the types within an ordination. In the vegetation analyses, where data from 80 stands were available, a "composite" data set, which was composed of only those recognized vegetation types and those species occurring in at least 66 percent of the stands comprising that type, was created to eliminate much of the "noise" associated with each of the vegetation types, and to better highlight the relationships inherent amongst the various types. In the soil analyses, no composite data set was necessary for simplification, since data was only available for 29 stands. The analysis used the data from all 29 stands.

#### 3.2.2 Mineral Soil Analyses

Particle size analyses were conducted in the Hydraulics Laboratory, Canada Centre for Inland Waters. The method incorporates sieving and sedigraph techniques with no pre-treatments except for the use of a dispersing agent (Duncan and Lattaie, 1979).

Chemical analyses including: pH in $CaCl_2$; cation exchange capacity; exchangeable K, Ca and Mg; organic and inorganic carbon; pyrophosphate extractable and dithionite extractable Fe and Al; total S; and sodium-phosphate extractable and water soluble sulphate were performed on the bulk samples from each horizon. Preliminary results of the 12 sites sampled in 1980 are reported in Cowell and Wickware (1983).

#### 3.2.3 Mineralogical Analyses

Subsoil till and outwash sediments from the soil pits (primarily C or BC horizons - 24 samples) and gravel pit exposures (5 samples) were subjected to mineralogical analyses. The results of these analyses are reported separately (Kusmirsky and Cowell, 1983).

## 4.0 RESULTS AND DISCUSSION

### 4.1 Classification

#### 4.1.1 Vegetation

On the basis of data collected from the 80 stands, 17 forest vegetation types have been recognized in the watershed. Fifteen of these types were determined using TWINSPAN (Figure 2) while two other sampled types, representing relative extremes in site conditions, were also accorded type status. A summary of the cover-abundance data for the 123 taxa encountered, summarized alphabetically by strata for 15 of the forest vegetation types, is provided in Table 2. In addition, the two-way table produced by TWINSPAN was analysed further and 21 species groups were recognized. These species groups (Table 3) were used in characterizing the vegetation types discussed later in this paper. Decisions regarding acceptance of the types and species groups produced by TWINSPAN were, as with most classifications, somewhat arbitrary, although every effort was made to produce a classification which best highlighted the differences observed in the

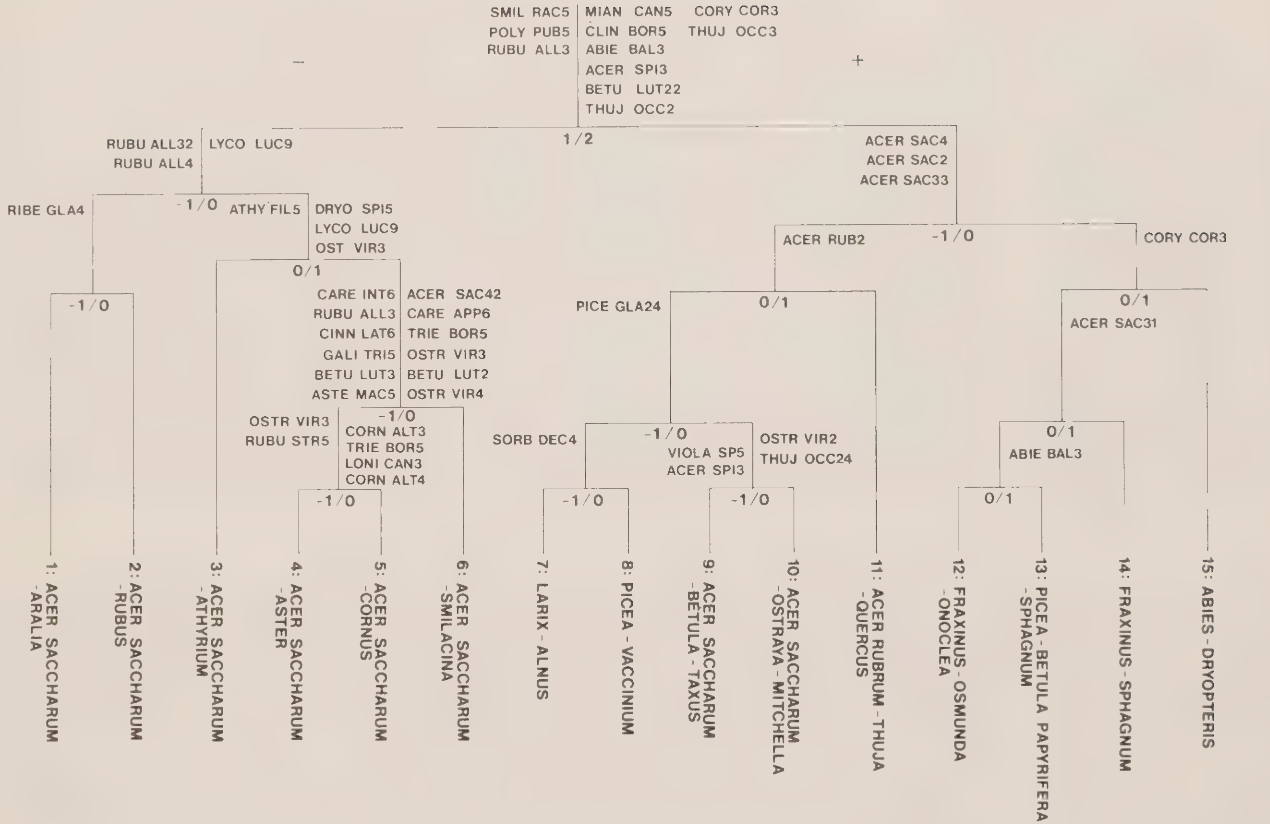



FIGURE 2. TWINSPAN DENDROGRAM FOR FIFTEEN FOREST VEGETATION TYPES IN THE TURKEY LAKES WATERSHED.

Indicator species at each level in the division process are included. The first number after the species name is the layer code (2 - trees; 3 - tall/medium shrubs 0.5-10 m; 4 - low/dwarf shrubs under 2 m; 5 - herbs; 6 - grasses/sedges; 9 - moss). The second number, where present, indicates cover abundance (1 - 0.5-2%; 2 - 2-5%; 3 - 5-10%; 4 - 10-20%, 5 - over 20%).

TABLE 2. COVER ABUNDANCE DATA

Cover abundance data for 123 taxa encountered, summarized alphabetically by strata for fifteen vegetation types of the Turkey Lake Watershed. Mean cover (when present) for all sites classified into one of fifteen forest vegetation types is the first value given for those species occurring in the plots (1 =<2%, 2 = 2-5%, 3 = 5-10%, 4 = 10-20%, 5 =>20%). Values in parentheses indicate percentage presence of species for each forest vegetation type.

| | UPLAND HARDWOOD | | | | | | UPLAND MIXEDWOOD | | | | | | WETLAND MIXEDWOOD | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Acer/Aralia-Rubus (n=3) | Acer/Rubus (n=6) | Acer/Athyrium (n=8) | Acer/Aster (n=6) | Acer/Cornus (n=7) | Acer/Smilacina (n=17) | Picea/Vaccinium (n=4) | Acer-Betula/Taxus (n=13) | Acer-Ostrya/Mitchella (n=6) | Acer rubrum-Thuja-Quercus (n=6) | Larix/Alnus (n=1) | Fraxinus/Osmunda-Onoclea (n=1) | Picea-Betula Sphagnum (n=1) | Fraxinus/Sphagnum (n=1) | Abies Dryopteris (n=1) |
| Trees (n=14) | | | | | | | | | | | | | | | |
| *Abies balsamea* | | | | | | | 5[75] | 2[23] | 2[33] | 5[16] | | | 4[100] | 2[100] | 5[100] |
| *Acer rubrum* | 5[33] | 2[16] | | | | | | | | 4[100] | | | 4[100] | 1[100] | |
| *Acer saccharum* | 5[100] | 5[100] | 5[100] | 5[100] | 5[100] | 5[100] | 4[75] | 5[100] | 5[100] | 5[16] | | | | | |
| *Betula lutea* | | | 4[12] | 5[16] | 4[14] | 4[47] | 5[75] | 5[77] | 5[83] | 4[67] | | 5[100] | 5[100] | | 5[100] |
| *Betula papyrifera* | | | | | | | 4[50] | 1[8] | | 4[16] | 4[100] | | 5[100] | | |
| *Fraxinus nigra* | | | | | | | | | | | | 5[100] | | 5[100] | |
| *Larix laricina* | | | | | | | | | | | 5[100] | | | | |
| *Ostrya virginiana* | | | | 4[14] | | 4[30] | | | | | | | | | |
| *Picea glauca* | | | | | | | 5[100] | 2[15] | 2[16] | 4[33] | 4[100] | 5[100] | 5[100] | 4[100] | |
| *Pinus strobus* | | | | | | | | | 1[16] | 4[50] | | 2[100] | | | |
| *Prunus virginiana* | | | | | 2[14] | | | | | 4[66] | | 2[100] | | | |
| *Quercus rubra* | | | | | | | | | | 2[33] | | | | | 3[100] |
| *Sorbus decora* | 5[33] | | | | | | 2[25] | | | 5[33] | | 2[100] | | | |
| *Thuja occidentalis* | | | | | | | 4[75] | 3[8] | 4[66] | 4[83] | 5[100] | | | 2[100] | 4[100] |
| Shrubs (n=32) | | | | | | | | | | | | | | | |
| *Abies balsamea* | | | | 1[16] | | 1[35] | 2[100] | 2[100] | 2[66] | 2[100] | 2[100] | | 3[100] | | |
| *Acer rubrum* | 3[66] | 5[33] | | 1[33] | 2[57] | 3[47] | 1[75] | 3[62] | 2[50] | 4[100] | 1[100] | 4[100] | 3[100] | 2[100] | |
| *Acer saccharum* | 3[100] | 5[100] | 5[100] | 5[66] | 5[100] | 5[100] | 4[100] | 4[100] | 3[83] | 3[83] | 4[100] | | | 2[100] | 1[100] |
| *Acer spicatum* | | | 2[25] | | 1[14] | | 4[100] | 3[77] | 2[16] | 1[16] | 5[100] | | 2[100] | 4[100] | 3[100] |
| *Alnus rugosa* | | | | | | | | | | | 2[100] | | | | |
| *Amelanchier* sp. | | | | 1[33] | 1[14] | 1[12] | 1[25] | | | 1[16] | 1[100] | | 1[100] | | |
| *Aralia nudicaulis* | 3[100] | 4[33] | 2[12] | 2[16] | 2[28] | 1[29] | 2[75] | 2[46] | | 1[50] | 1[100] | | | | |
| *Betula lutea* | | 1[33] | 1[50] | 2[66] | 1[71] | 1[24] | 2[75] | 2[85] | 2[66] | 2[50] | 1[100] | | 2[100] | 2[100] | 2[100] |
| *Betula papyrifera* | | | | | | | 2[25] | 1[8] | | | | | | | |
| *Cornus alternifolia* | | | | | 4[57] | | | 1[8] | | | | | | | |
| *Corylus cornuta* | | | | | 1[29] | 1[24] | 2[75] | 2[77] | 1[66] | 2[50] | 2[100] | | | | 1[100] |
| *Fraxinus nigra* | | | | | | | | | | | | | | 2[100] | 1[100] |
| *Lonicera canadensis* | | | | | 1[43] | 1[59] | 1[100] | 1[85] | 1[83] | 1[33] | 2[100] | | | 2[100] | 1[100] |
| *Ostrya virginiana* | | | | 3[83] | 3[86] | 2[71] | | 2[8] | | | | | | 2[100] | |
| *Picea glauca* | | | | | | 1[29] | 2[25] | 1[54] | 1[16] | 3[66] | 2[100] | | | 2[100] | 3[100] |
| *Pinus strobus* | | | | 1[33] | | 1[18] | 1[25] | 1[8] | 1[50] | 1[50] | | | | | |
| *Prunus penslyvanica* | | | | | | | | | | 1[33] | | | | | |
| *Prunus virginiana* | 3[100] | 1[33] | 1[38] | 1[16] | | 1[12] | | | | 4[16] | | | | | |
| *Quercus rubra* | | 1[33] | | | 1[14] | | | 1[15] | 1[50] | 3[83] | | | | | 1[100] |
| *Ribes glandulosum* | 1[100] | | 2[25] | | | | | | | | | | | | |
| *Ribes triste* | | 1[12] | | | | | | | | | | | | | |
| *Rubus allegheniensis* | 2[100] | 5[100] | 1[25] | 2[66] | 1[71] | 2[18] | 1[25] | 2[8] | | | | | | | |
| *Rubus pubescens* | | | 1[25] | | | | | 2[8] | | | 1[100] | | | 2[100] | 1[100] |
| *Rubus strigosus* | 5[100] | 1[33] | 1[63] | 1[16] | 1[14] | | | | | | | | | | |
| *Sambucus pubens* | | 1[33] | 1[88] | 1[50] | 1[8] | 1[12] | | 1[15] | | 2[33] | | | | | |
| *Taxus canadensis* | | | | | | 1[24] | | 3[62] | 1[50] | 1[16] | 3[100] | | | | |
| *Sorbus americana* | | | | | | 1[12] | 2[25] | 1[15] | | 3[83] | 1[100] | | 2[100] | 1[100] | 1[100] |
| *Sorbus decora* | 4[33] | 1[83] | 1[50] | 1[16] | 1[43] | 1[24] | 2[25] | 1[15] | 1[50] | 3[66] | 2[100] | 2[100] | 4[100] | | 2[100] |
| *Thuja occidentalis* | | | | | | | 2[75] | 2[23] | 1[33] | | | | | | |
| *Ulmus americana* | 2[100] | | 1[50] | | | | | | | 1[33] | | | | | |
| *Vaccinium myrtilloides* | | | | | | | | | | 1[50] | | | | 2[100] | |
| *Vaccinium ovalifolium* | | | | | | | 2[75] | 1[8] | 1[16] | | | | | | |
| Herbs (n=4[illegible]) | | | | | | | | | | | | | | | |
| *Aster macrophyllus* | | | | 4[50] | 2[28] | | | | | | | | | | |
| *Athyrium filix-femina* | | | 2[75] | | | 1[8] | 1[25] | 4[8] | | | | | | | 3[100] |
| *Caltha palustris* | | | | | | | | | | | | | | 2[100] | |
| *Clintonia borealis* | 1[66] | | 1[12] | 2[16] | 2[43] | 1[12] | 4[100] | 2[85] | | 2[83] | 2[100] | | 2[100] | 1[100] | |
| *Coptis trifolia* | | | | | | | 1[75] | 2[8] | | 4[33] | 2[100] | 5[100] | 5[100] | 4[100] | |
| *Cornus canadensis* | | | | | | | 1[75] | 2[8] | | | 1[100] | | 1[100] | | |
| *Cypripedium acaule* | | | | | | | 1[25] | | 1[16] | 1[83] | 1[100] | 1[100] | 1[100] | 4[100] | 4[100] |
| *Dentaria diphylla* | | | | | | | | | | | | | | | 1[100] |
| *Dryopteris spinulosa* | 1[100] | 1[100] | 3[25] | 1[66] | 1[100] | 1[94] | 2[75] | 2[92] | 1[83] | | | | | | |
| *Erythronium americanum* | | | | | | 1[8] | | 1[23] | | | | 2[100] | | | |
| *Eupatorium maculatum* | | | | | | | | | | | 1[100] | | | | |
| *Equisetum arvense* | | | | | | | | | | | | | | 2[100] | |
| *Equisetum sylvaticum* | | | | | | | | | | | | | | 1[100] | 1[100] |
| *Galium triflorum* | | | 1[25] | 1[33] | 1[43] | | 1[25] | | | | 1[100] | | | | |
| *Gaultheria hispidula* | | | | | | | | | | | 1[100] | | | 1[100] | |
| *Gymnocarpium dryopteris* | | | 1[12] | | | | | | | | | | | | |
| *Habenaria orbiculata* | | | | 1[16] | 1[14] | | | | | | | | | 1[100] | |
| *Habernaria* spp. | | | | | | | | | | | | | | | |
| *Impatiens biflorum* | | 1[13] | | | | | | | | | | 2[100] | | | |
| *Impatiens capensis* | | | | | | | | | | | | 1[100] | | | |
| *Iris versicolor* | | | | | | | | | | | 1[100] | | | | |
| *Linnaea borealis* | | | | | | | | | | 2[100] | 1[100] | | | 1[100] | |

Table 2. Continued

| Species | UPLAND HARDWOOD | | | | | UPLAND MIXEDWOOD | | | | | WETLAND MIXEDWOOD | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Acer/Aralia-Rubus* (n=3) | *Acer/Rubus* (n=6) | *Acer/Athyrium* (n=8) | *Acer/Aster* (n=6) | *Acer/Cornus* (n=7) | *Acer/Smilacina* (n=17) | *Picea/Vaccinium* (n=4) | *Acer-Betula/Taxus* (n=13) | *Acer-Ostrya/Mitchella* (n=6) | *Acer rubrum-Thuja-Quercus* (n=6) | *Larix/Alnus* (n=1) | *Fraxinus/Osmunda-Onoclea* (n=1) | *Picea-Betula Sphagnum* (n=1) | *Fraxinus/Sphagnum* (n=1) | *Abies Dryopteris* (n=1) |
| *Maianthemum canadense* | 1[66] | 1[13] | 1[12] | | 1[14] | 1[18] | 2[100] | 2[62] | 1[50] | | | | | | |
| *Mitchella repens* | | | | | | 1[18] | 1[25] | 1[31] | 2[505] | | 1[100] | | | | 1[100] |
| *Mitella nuda* | | | | | | | | | | | | | | | 1[100] |
| *Moneses uniflora* | | | | | | | | | | | | 5[100] | | 5[100] | 1[100] |
| *Onoclea sensibilis* | | | | | | | | | | | | | 2[100] | 5[100] | |
| *Osmunda cinnamomea* | | | | | | | | | | | | | | | |
| *Osmunda claytoniana* | | | 4[12] | | | | | | | | | | | | |
| *Osmunda regalis* | | | | | | | 2[25] | 5[8] | | | | 5[100] | | 4[100] | |
| *Polygonatum pubescens* | 1[33] | 1[100] | 1[38] | 1[66] | 1[100] | 1[82] | | 1[38] | | | | | | | |
| *Polygonum cilinode* | 1[100] | 1[33] | 1[50] | | | 1[8] | | | 1[16] | | | | | | |
| *Smilacina racemosa* | 2[100] | 2[100] | 2[100] | 2[100] | 2[100] | 2[100] | | 1[62] | 1[85] | 1[33] | | | | | |
| *Streptopus amplexifolius* | | | | | | | | | | | 1[100] | | | | |
| *Streptopus roseus* | 1[33] | 1[66] | 1[88] | 1[100] | 1[100] | 1[94] | 1[75] | 1[100] | 1[100] | 1[66] | 1[100] | | 1[100] | | |
| *Thalictrum dioicum* | | | 2[12] | 2[33] | | | | | | | | | | | |
| *Thelypteris phegopteris* | | | | | | | 1[25] | 1[23] | 1[16] | | 1[100] | | | | 1[100] |
| *Trientalis borealis* | 1[33] | 3[50] | 1[25] | | 1[43] | 1[53] | 1[75] | 1[69] | 1[66] | 1[83] | 1[100] | | 1[100] | 2[100] | 1[100] |
| *Trillium spp.* | | | 1[12] | | | | | | | | | | | | 1[100] |
| *Viola renifolia* | | | | | | | 1[25] | | | | | | | | |
| *Viola cucullata* | | 1[13] | | | | | | | | | | | | 5[100] | 1[100] |
| *Viola spp.* | | 1[50] | 1[50] | 1[100] | 1[71] | 1[65] | 1[75] | 1[92] | 1[16] | 1[16] | 1[100] | 1[100] | 1[100] | | |
| Graminoids (n=11) | | | | | | | | | | | | | | | |
| [illegible] | | | 1[25] | | 1[29] | | | 1[15] | | | | | | | |
| *Carex arctata* | | | 1[12] | 1[16] | 1[29] | 1[18] | | | 1[16] | | | | | | |
| *C. disperma* | | | | | | | | | | | | | | 1[100] | |
| *C. intumescens* | 1[33] | 1[50] | 1[12] | 1[50] | 1[86] | | | 1[8] | 1[16] | | | | | 1[100] | |
| *C. leptalea* | | | | | | | | | | | | | | | 1[100] |
| *C. pedunculata* | | | | | | | 1[25] | | | | | | | | |
| *C. scabrata* | | 1[13] | | | | | | | | | | | | | |
| *C. trisperma* | | | | | | | | 1[8] | | | 1[100] | 2[100] | 1[100] | 4[100] | |
| *Carex spp.* | | | | | | 1[41] | 1[25] | 2[54] | 2[33] | 1[83] | 1[100] | | | | 5[100] |
| *Cinna latifolia* | 2[100] | 1[50] | 1[50] | 1[33] | 1[71] | 1[12] | | 1[8] | | | | | | 1[100] | |
| *Glyceria striata* | | | | | | | | | | | | | | | 1[100] |
| Bryophytes and Lichens (n=24) | | | | | | | | | | | | | | | |
| *Cladina mitis* | | | | | | | | | | | | | | | 1[100] |
| *Cladina spp.* | | | | | | 1[8] | | | | | | | | | |
| *Climacium dendroides* | | | | | | | | | | | | | | 1[100] | |
| *Dicranum fuscescens* | | | | | | 1[8] | | | | | | | | | |
| *Dicranum spp.* | | | | | | 1[18] | 1[25] | 2[8] | 1[16] | | | | | | 1[100] |
| *Drepanocladus spp.* | | | | | | | | 1[8] | | | | | | 1[100] | |
| *Lycopodium lucidulum* | | | 1[12] | 2[66] | 2[100] | 2[76] | 4[75] | 4[100] | 2[66] | 2[50] | | | | | |
| *L. obscurum* | | | | | | | | 2[8] | 1[33] | 1[33] | | | | | 1[100] |
| *Marchantia polymorpha* | | | 1[12] | | | | | | | | | | | | |
| *Mnium affine* | | | 1[12] | | | | | 1[8] | | | 1[100] | | | | 1[100] |
| *M. pseudopunctatum* | | | | | | | | | | | | 2[100] | | | 1[100] |
| *M. punctatum* | | | | | | | | | | | | | | 5[100] | |
| *Neckera spp.* | | | | | | 1[8] | | | | | | | | | |
| *Paraleucobryum spp.* | | 1[13] | 1[12] | 1[16] | | 1[29] | | 1[23] | 1[33] | 1[16] | | | | | |
| *Phryma leptostachya* | | | 1[12] | | | | | | | | | | | | 1[100] |
| *Pleurozium schreberi* | | | | | | | | 1[15] | | | 1[100] | | | | 1[100] |
| *Polytrichum commune* | | | | | | 1[8] | 1[50] | | | 1[16] | | | | | |
| *P. juniperinum* | | | | | 1[14] | | 1[25] | 1[15] | 1[50] | 1[50] | | | | | |
| *Ptilium crista-castrensis* | | | | | | | | | | | | 1[100] | | | |
| *Rhydobryum roseum* | | | 1[12] | | | | | | | | | 1[100] | | | 3[100] |
| *Sphagnum cuspidatum* | | | | | | | | 1[8] | | | | 2[100] | | 4[100] | |
| *S. girgensohnii* | | | | | | | | | | | 1[100] | | 5[100] | | |
| *S. magellanicum* | | | | | | | | | | | | 1[100] | | | |
| *S. nemoreum* | | | | | | | | | | | 1[100] | | | | |

Total No. of Taxa: 123

TABLE 3: TWENTY-ONE (21) SPECIES GROUPS OF THE TURKEY LAKES WATERSHED AS INTERPRETED FROM TWINSPAN. Number following the species name indicates the stratum [2 = Tree ( > 10m); 3 = Tall Shrub (2-10m); 4 = Low and Dwarf Shrub ( < 2m); 5 = Herb; 6 = Grasses and Sedges; 7 = Feathermoss; 8 = Sphagnum Moss; 9 = Lichens and Other Mosses].

| *Rubus strigosus* Species Group | |
|---|---|
| *Ribes glandulosum* | 4 |
| *Rubus strigosus* | 5 + 4 |
| *Prunus virginiana* | 3 |
| *Polygonum cilinode* | 5 |
| *Ulmus americana* | 4 |

| *Cinna latifolia* Species Group | |
|---|---|
| *Ulmus americana* | 3 |
| *Cinna latifolia* | 6 |
| *Sambucus pubens* | 3 |

| *Samubucus pubens* Species Group | |
|---|---|
| *Viola eriocarpa* | 5 |
| *Osmunda claytoniana* | 5 |
| *Carex scabrata* | 6 |
| *Impatiens capensis* | 5 |
| *Ribes glandulosum* | 3 |
| *Rubus occidentalis* | 5 |
| *Sambucus pubens* | 5 |

| *Smilacina racemosa* Species Group | |
|---|---|
| *Smilacina racemosa* | 5 |
| *Athyrium felix-femina* | 5 |
| *Rubus strigosus* | 5 |
| *Brachyelytrum erectum* | 6 |

| *Acer saccharum* (tree) Species Group | |
|---|---|
| *Acer saccharum* | 2 + 3 |

| *Rubus allegheniensis* Species Group | |
|---|---|
| *Aralia nudicaulis* | 4 |
| *Rubus allegheniensis* | 3 + 4 |
| *Prunus virginiana* | 4 |

| *Polygonatum biflorum* Species Group | |
|---|---|
| *Carex intumescens* | 6 |
| *Polygonatum pubescens* | 5 |
| *Galium triflorum* | 5 |

| *Cornus alternifolia-Aster macrophyllus* Species Group | |
|---|---|
| *Neckera* spp. | 9 |
| *Dicranum fuscescens* | 9 |
| *Moneses uniflora* | 5 |
| *Thalictrum dioicum* | 5 |
| *Rubus strigosus* | 5 |
| *Habenaria orbiculata* | 5 |
| *Aster macrophyllus* | 5 |
| *Prunus virginiana* | 2 |
| *Cornus alternifolia* | 3 + 4 |
| *Ostrya virginiana* | 4 |
| *Carex arctata* | 6 |
| *Sambucus pubens* | 4 |
| *Ostrya virginiana* | 3 |

| *Streptopus roseus* Species Group | |
|---|---|
| *Ostrya virginiana* | 2 |
| *Streptopus roseus* | 5 |
| *Amelanchier* | 3 |
| *Viola* spp. | 5 |

| *Dryopteris spinulosa* Species Group | |
|---|---|
| *Acer saccharum* | 4 |
| *Paraleucobryum* spp. | 9 |
| *Lonicera canadensis* | 3 |
| *Pinus strobus* | 4 |
| *Dryopteris spinulosa* | 5 |
| *Trillium* spp. | 5 |
| *Ribes triste* | 4 |
| *Marchantia polymorpha* | 9 |
| *Phryma leptobryum* | 9 |
| *Aralia nudicaulis* | 5 |

| *Viola cucullata* Species Group | |
|---|---|
| *Sorbus decora* | 2 |
| *Carex* spp. | 6 |
| *Mnium affine* | 9 |
| *Viola cucullata* | 5 |
| *Rhodobryum roseum* | 9 |
| *Picea glauca* | 4 |
| *Betula lutea* | 2 |

| *Clintonia borealis* Species Group | |
|---|---|
| *Polytrichum commune* | 9 |
| *Sorbus americana* | 3 |
| *Mitchella repens* | 5 |
| *Maianthemum canadense* | 5 |
| *Clintonia borealis* | 5 |

| *Acer spicatum* Species Group | |
|---|---|
| *Pleurozium schreberi* | 9 |
| *Osmunda regalis* | 5 |
| *Coptis trifolia* | 5 |
| *Picea glauca* | 2 + 3 |
| *Betula papyrifera* | 2 |
| *Thuja occidentalis* | 4 |
| *Abies balsamea* | 2 + 3 |
| *Acer spicatum* | 3 |
| *Pinus strobus* | 2 |

TABLE 3: Continued

| | |
|---|---|
| ***Lycopodium lucidulum-Trientalis borealis* Species Group** | |
| *Gymnocarpium dryopteris* | 5 |
| *Rubus pubescens* | 5 |
| *Betula lutea* | 3 + 4 |
| *Pinus strobus* | 3 |
| *Lycopodium lucidulum* | 9 |
| *Dicranum* spp. | 9 |
| *Trientalis borealis* | 5 |
| ***Sorbus decora-Acer rubrum* Species Group** | |
| *Acer rubrum* | 3 |
| *Sorbus decora* | 3 |
| *Quercus rubra* | 4 |
| ***Acer rubrum* (tree) Species Group** | |
| *Quercus rubra* | 3 |
| *Acer rubrum* | 2 + 4 |
| *Sorbus decora* | 4 |
| ***Corylus cornuta* Species Group** | |
| *Erythronium americanum* | 5 |
| *Taxus canadensis* | 4 |
| *Abies balsamea* | 4 |
| *Lonicera canadensis* | 4 |
| *Sorbus americana* | 4 |
| *Corylus cornuta* | 3 |
| ***Vaccinium ovalifolium* Species Group** | |
| *Vaccinium ovalifolium* | 4 |
| *Vaccinium myrtilloides* | 4 |
| *Prunus pensylvanica* | 3 |
| *Polytrichum juniperinum* | 9 |
| *Quercus rubra* | 2 |
| *Lycopodium obscurum* | 9 |
| *Thuja occidentalis* | 2 |
| ***Thuja occidentalis* Species Group** | |
| *Thuja occidentalis* | 3 |
| ***Carex trisperma* Species Group** | |
| *Drepanocladus* spp. | 9 |
| *Mitella nuda* | 5 |
| *Eupatorium maculatum* | 5 |
| *Habenaria* spp. | 5 |
| *Monotropa uniflora* | 5 |
| *Fraxinus nigra* | 3 + 4 + 2 |
| *Cladina mitis* | 9 |
| *Dentaria diphylla* | 5 |
| *Equisetum sylvaticum* | 6 + 5 |
| *Glyceria striata* | 6 |
| *Carex leptalea* | 6 |
| *Caltha palustris* | 5 |
| *Onoclea sensibilis* | 5 + 6 |
| *Mnium punctatum* | 9 |
| *Carex disperma* | |
| *Climacium dendroides* | |
| *Osmunda cinnamomea* | 5 |
| *Ptilium cristra-castrensis* | 7 |
| *Sphagnum magellanicum* | 8 |
| *Mnium pseudopunctatum* | 9 |
| *Carex trisperma* | 6 |
| *Impatiens capensis* | |
| *Sphagnum cuspidatum* | 8 |
| *Osmunda regalis* | 6 |
| *Iris versicolor* | 5 |
| ***Thelypteris phegopteris* Species Group** | |
| *Cornus canadensis* | 5 |
| *Aster* spp. | 5 |
| *Linnaea borealis* | 5 |
| *Streptopus amplexifolius* | 5 |
| *Equisetum arvense* | 5 |
| *Gaultheria hispidula* | 5 |
| *Sphagnum nemoreum* | 8 |
| *Sphagnum girgensohnii* | 8 |
| *Alnus rugosa* | 3 |
| *Larix laricina* | 2 |
| *Carex pedunculata* | 6 |
| *Cypripedium acaule* | 5 |
| *Sambucus pubens* | 5 + 4 |
| *Viola renifolia* | 5 |
| *Betula papyrifera* | 3 |
| *Corylus cornuta* | 4 |
| *Thelypteris phegopteris* | 5 |
| *Acer spicatum* | 4 |
| *Taxus canadensis* | 3 |

field, and would allow for the most sensible interpretation with respect to the significant underlying physical and/or environmental gradients.

The vegetation types can be broadly categorized into three major groups:

UPLAND HARDWOOD TYPES
- *Juniperus communis/Vaccinium myrtilloides*[1]
- *Acer saccharum/Aralia nudicaulis-Rubus strigosus*
- *Acer saccharum/Rubus allegheniensis*
- *Acer saccharum/Athyrium filix-femina*
- *Acer saccharum/Aster macrophyllus*
- *Acer saccharum/Cornus alternifolia*
- *Acer saccharum/Smilacina racemosa*

UPLAND MIXEDWOOD TYPES
- *Picea glauca/Vaccinium ovalifolium*
- *Acer saccharum-Betula lutea/Taxus canadensis*
- *Acer saccharum-Ostrya virginiana/Mitchella repens*
- *Acer rubrum-Thuja occidentalis-Quercus rubra*

WETLAND MIXEDWOOD TYPES
- *Fraxinus nigra-Osmunda regalis-Onoclea sensibilis*
- *Picea glauca-Betula papyrifera/Sphagnum girgensohnii*
- *Acer saccharum/Impatiens capensis*[1]
- *Fraxinus nigra/Sphagnum cuspidatum*
- *Abies balsamea/Dryopteris spinulosa*
- *Larix laricina/Alnus rugosa*

Figure 2 reveals these three basic groupings. Types one through six represent the Upland Deciduous Group; types eight through eleven the Upland Mixedwood Group; and types twelve through fifteen the Wetland Mixedwood Group. Type seven (*Larix laricina/Alnus rugosa*) although included in the TWINSPAN results as part of the Upland Mixedwood Group is in fact an organic soil type and hence has been reallocated to the Wetland Mixedwood Group.

As a result of applying the classification key (Figure 2) on a large number of stands (420) in the field during the mapping phase of the project, a number of useful refinements to the classification were made. Principally, the changes involved the *"Acer saccharum/Smilacina racemosa"* type and the *"Acer saccharum-Betula lutea/ Taxus canadensis"* type. In both instances, phases or varieties were warranted. In the *"Acer saccharum/Smilacina racemosa"* type, four variants or phases were recognized: a) a "shrub-rich" variant in which *Acer saccharum* in the 2-10 m range is quite dense with few understory herbs present; b) a "herb-rich" variant in which the shrub cover is low, individuals are scattered, and both the cover and complement of herbs are high; c) a *"Maianthemum canadense"* variant, which includes other typical boreal species such as *Clintonia borealis, Taxus canadensis* Marsh., *Trientalis borealis* and *Lycopodium lucidulum* Michx. This was noted in the field as the "boreal" variant; d) the *"Acer rubrum"* variant which usually included *Ostrya virginiana* in the tree layer and occurred exclusively on the upper and west facing slope positions. In the *"Acer saccharum-Betula lutea/Taxus canadensis"* type, a wetland/lower slope position *"Thuja occidentalis"* variant was recognized. In this variant, because of the greater soil moisture and lower slope position, the *Thuja occidentalis* replaces the *Taxus canadensis*. Complete descriptions of these variants are provided in Section 5.0 of this paper.

In addition to these modifications to the original vegetation types, a number of new types were recognized during the mapping phase of the program. A summary of these types and brief descriptions are provided in in Section 6.5.

At the conclusion of the mapping phase of the survey, it was found that the most frequently occurring vegetation type in the watershed is the *"Acer saccharum/Smilacina racemosa"* type (V6), which was encountered 60% of the time during the transect sampling. Of this percentage, the shrub-rich variant ($V6_1$) is the most dominant, occuring 32% of the time. The *"Acer saccharum-Betula lutea/Taxus canadensis"* (V9) occurred 17% of the time and the *"Acer rubrum-Thuja-Quercus"* type (V11) 15% of the time. The remaining types occurred infrequently.

### 4.1.2 Soils

A total of 29 stands for which soil data was available were classified in a fashion similar to the vegetation data, using the TWINSPAN program. A summary of the soil variables used in the classification procedures is provided in Table 4. The classification resulted in six soil types being recognized (Figure 3). Although the types are named using soil textures, Figure 3 shows that other variables were also used in differentiating the types. Three additional types were recognized during the 1982 field mapping program. These additional types include: a) soil type 7, a "sandy clay loam-clay loam/clay loam-very fine-fine-medium sand"; b) soil type 8, a "silty clay

1 Types not determined using TWINSPAN

loam/very fine-fine-medium sand"; and c) soil type 9, a "shallow soil" type, usually very bouldery with little fine matrix soil material.

Use of the soil classification key (Figure 3) proved time consuming in field applications and so a second key, manually derived and based on soil textures (surface/subsurface), was used during the mapping program. This key is presented in Figure 4.

During the data collection program in the mapping phase of the project, the most

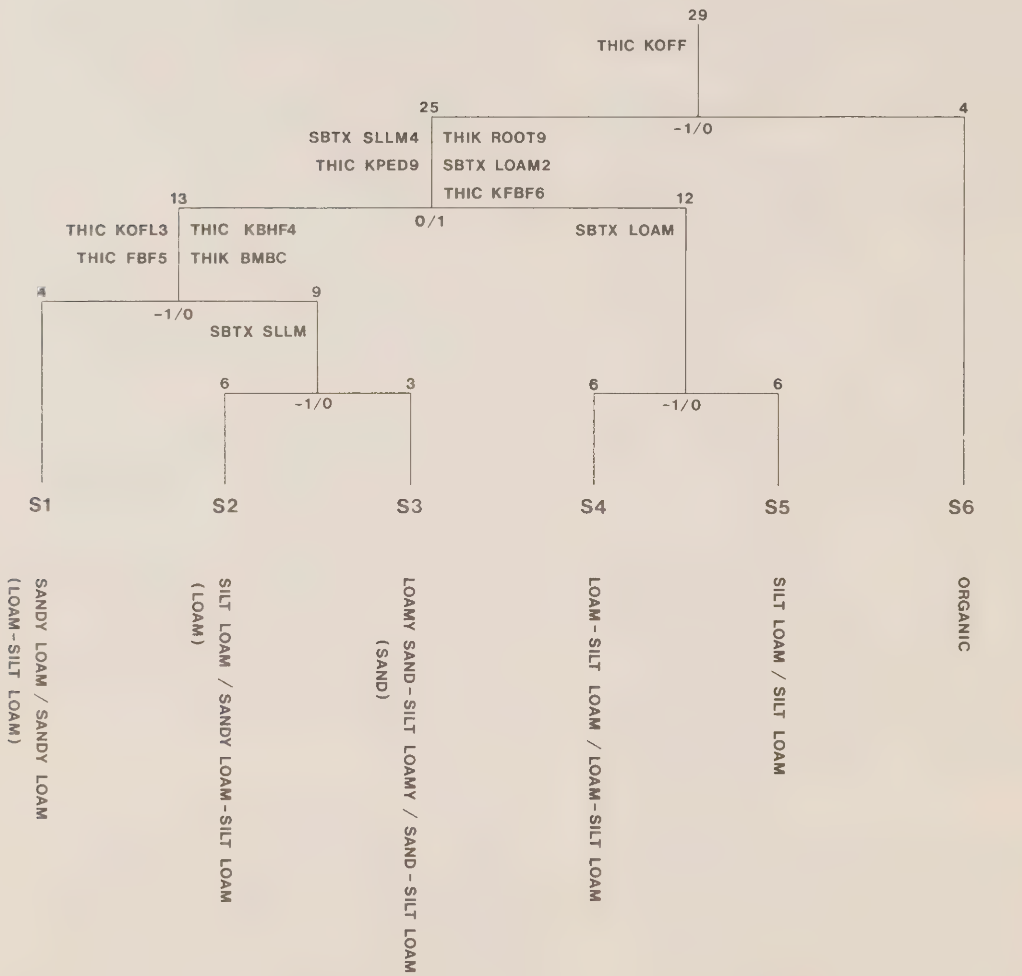



FIGURE 3: TWINSPAN DENDROGRAM FOR SIX SOIL TYPES IN THE TURKEY LAKES WATERSHED.*

* Soil variable indicators are shown at each level of division. An explanation of variable codes is provided in Table 4. Numerical values following each variable represent the percentage occurence in the soil profile (1 - 0.5-10%; 2 - 11-20%; 3 - 21-30%; 4 - 31-40%; 5 - 41-50%, 6 - 51-60%; 7 - 61-70%, 8 - 71-80%; 9 - over 80%).

frequently encountered soil type was silt loam/silt loam (S5) at 31%. Soil type 4 was second at 26% and soil type 3 at 17%. The remaining types were infrequently encountered (5% of the time or less).

### 4.2 Ordination

#### 4.2.1 Vegetation

Using the "composite" vegetation data set described earlier, ordination of 16 of the 17 vegetation types was carried out using the Cornell Ecology Program DECORANA (CEP40). Results of the ordination are presented in Figure 5. Three relatively distinct clusters, relating to the three major groups, the Upland Hardwood group, the Upland Mixedwood group and the Wetland Mixedwood group, discussed earlier can be readily observed. The first axis has been interpreted as a complex environmental gradient relating generally to elevation, slope position and soil moisture. The *"Acer saccharum/Aralia nudicaulis"* and *"Larix laricina/Alnus rugosa"* types occupy the highest and driest crests and the lowest, wettest, wetland positions of Axis I, respectively. The elevational trend is somewhat complicated by localized influences relating to aspect, exposure and cold air drainage. Interpretation of the second axis was more difficult, largely due to the fact that the variation in species composition is a function of a number of inter-related factors that cannot be considered independently. Gauch et al (1977) have noted this problem and have cautioned that the "second and higher axis may be ecologically meaningless, curvelinear functions of lower axes" with reciprocal averaging and similar techniques. Interpretation, therefore, is often more difficult for all but a single major gradient (Beese, 1981).

#### 4.2.2 Soils

Ordination of the stands, using only soil attributes, was carried out in a manner similar to that for the vegetation. One of the difficulties any ordination technique experiences is that radically different stands can result in a compression of the remaining stands on the ordination axes, thereby obscuring the relationship between the stands. To avoid this problem and to

TABLE 4: SUMMARY OF SOIL PROFILE VARIABLES USED IN CLASSIFYING SOILS IN THE TURKEY LAKES WATERSHED. (COMPUTER CODE IS PROVIDED IN PARENTHESIS).

| | |
|---|---|
| Depth of LFH | [DEPT HLFH] |
| Thickness of L | [THiC KOFL] |
| Thickness of F | [THiC KOFF] |
| Thickness of H | [THiC KOFH] |
| Depth of Pedon | [THiC KPED] |
| Thickness of Ah/Ahe | [THiK AHHE] |
| Thickness of Bhf | [THiC KBHF] |
| Thickness of Bf | [THiC KFBF] |
| Thickness of Bm/Bc | [THiK BMBC] |
| *Surface Texture (0-25 cm) | [SRTX] |
| *Subsurface Texture (25+ cm) | [SBTX] |
| Thickness of Of | [THiK OFOF] |
| Thickness of Om | [THiK OFOM] |
| Thickness of Oh | [THiK OFOH] |
| Thickness of Rooting Zone | [THiK ROOT] |

*Texture code: STXX = Silt; CSSS = Coarse Sand; LCSS = Loamy Coarse Sand; COSS = Coarse Sand; SLAA = Sandy Loam; CLLO = Clay Loam; SLLM = Sandy Loam; LVFS = Loamy Very Fine Sand; SILL = Silt Loam; SICL = Silty Clay; SIVF = Silty Very Fine Sand; SISS = Silty Sand; LLLL = Loam; VFSS = Very Fine Sand; MSSS = Medium Sand; CLLL = Clay; LVFT = Loamy Very Fine Sand; MSST = Medium Sand; VFST = Very Fine Sand; SILM = Silt Loam; SIST = Silty Sand; SIVG = Silty Very Fine Sand; FSST = Fine Sand; LFST = Loamy Fine Sand; LMST = Loamy Medium Sand; SILT = Silt; OFFF = Organic, Fibric; OHHH = Organic, Humic; OMMM = Organic, Mesic.

## FIELD KEY TO SOIL TYPES

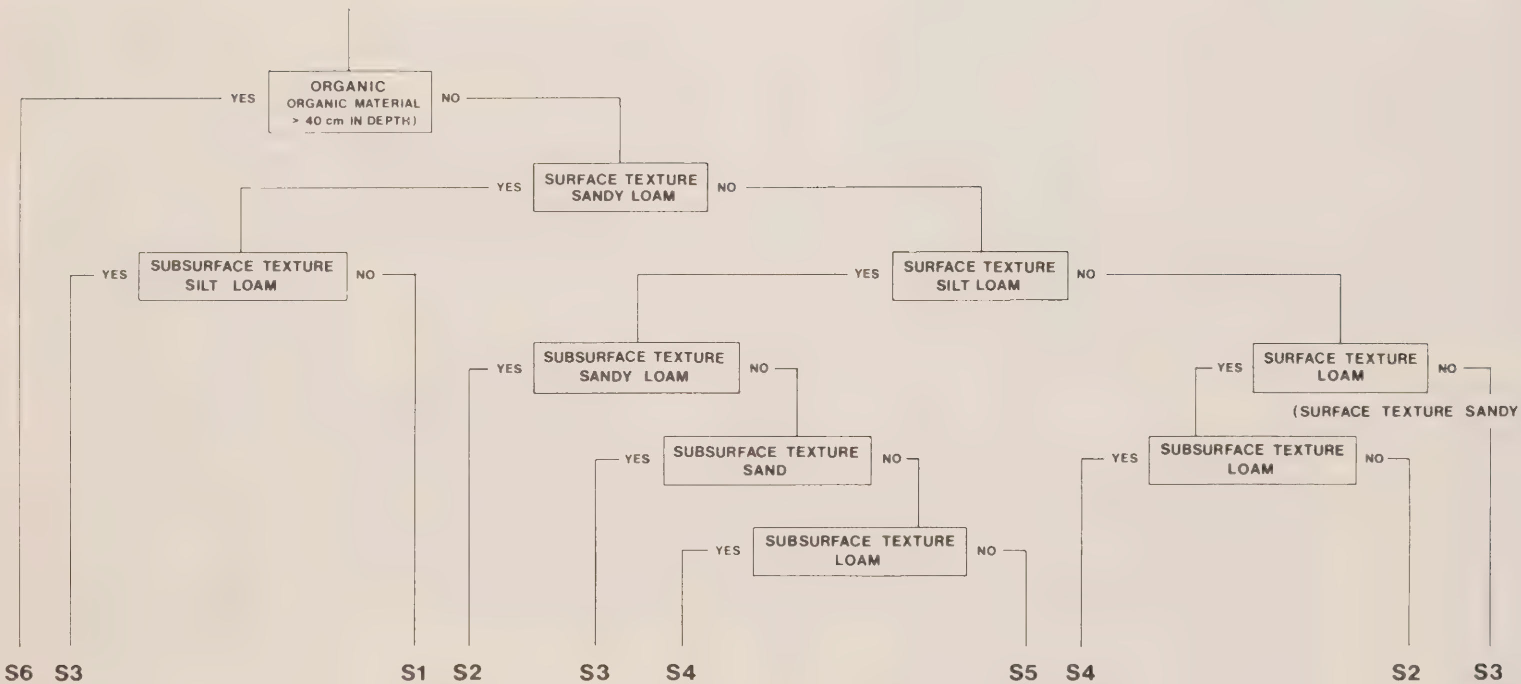
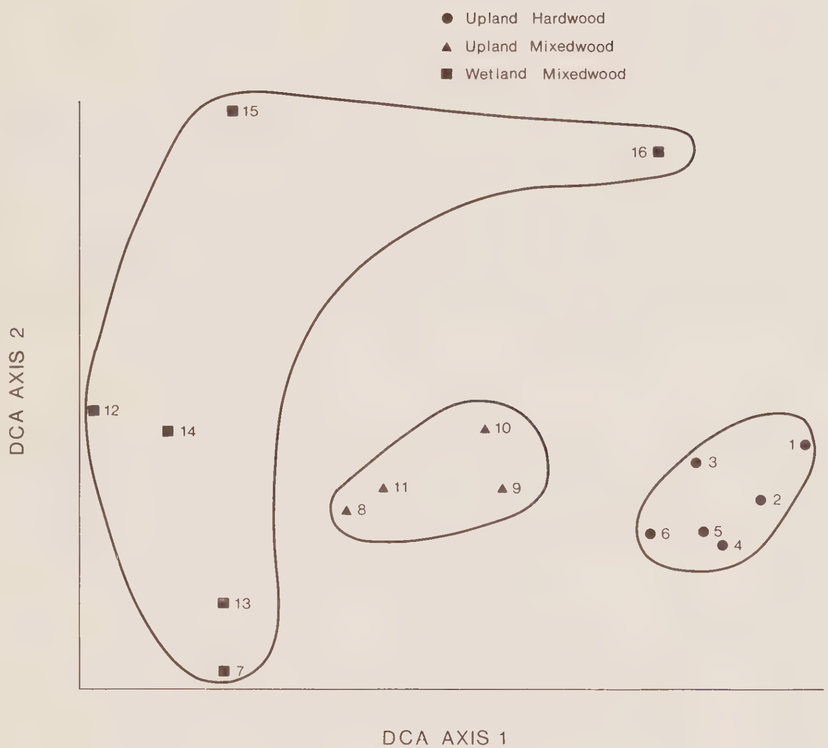



**FIGURE 4: MANUALLY DERIVED HIERARCHICAL KEY TO THE SOIL TYPES IN THE TURKEY LAKES WATERSHED.**

ONLY SURFACE (0-25 CM), AND SUBSURFACE (25+ CM) TEXTURE NEED BE USED TO ARRIVE AT THE SOIL TYPES DEFINED IN FIGURE 3.

## DECORANA ORDINATION FOR SIXTEEN FOREST VEGETATION TYPES




LEGEND

1 ACER SACCHARUM / ARALIA-RUBUS TYPE
2 ACER SACCHARUM / RUBUS TYPE
3 ACER SACCHARUM / ATHYRIUM TYPE
4 ACER SACCHARUM / ASTER TYPE
5 ACER SACCHARUM / CORNUS TYPE
6 ACER SACCHARUM / SMILACINA TYPE
7 LARIX / ALNUS TYPE
8 PICEA / VACCINIUM TYPE
9 ACER SACCHARUM-BETULA LUTEA / TAXUS TYPE
10 ACER SACCHARUM-OSTRYA / MITCHELLA TYPE
11 ACER RUBRA-THUJA / QUERCUS TYPE
12 FRAXINUS / OSMUNDA-ONOCLEA TYPE
13 PICEA-BETULA PAPYRIFERA / SPHAGNUM TYPE
14 FRAXINUS / SPHAGNUM TYPE
15 ABIES / DRYOPTERIS TYPE
16 ACER SACCHARUM / IMPATIENS TYPE

FIGURE 5: DETRENDED CORRESPONDENCE ANALYSIS ORDINATION (FIRST TWO AXES) OF SIXTEEN FOREST VEGETATION TYPES BASED ON A SYNTHETIC VEGETATIONAL COVER DATA SET OF ALL SPECIES.

improve the ordination results for the upland mineral soil stands, 4 of the 29 stands which were classified as organic soil types were excluded from the analyses. Results of the ordination of the remaining 25 mineral soil stands are presented in Figure 6.

Interpretation of the axes in Figure 6 revealed that a complex of site and environmental factors were at play along both axes. In general, axis 1 shows a trend along a moisture gradient, where soil types 1,2 and 3 tend to the dry-fresh condition and types 4 and 5 to the fresh-moist condition. Axis 2 trends along a nutrient gradient. An examiniation of Table 8 further revealed that soil type 4 has the thickest "H" and thinnest "F" surface organic horizons and the thickest "Bhf" mineral horizon. Thickness of the rooting zone is greatest in soil type 4. Soil type 5 was found to have almost equally as thick "H" and as thin "F" surface organic horizons as well as having the thickest "Ahe" mineral horizons. Soil type 3 has the thinnest surface organic horizons (LFH), although as a percentage of "LFH", "H" is high. Depth and development of the pedon is greatest and best expressed in soil type 3.

## 4.3 Vegetation-Soil-Environment Relationships

### 4.3.1 Vegetation-Environment Relationships

Table 5 provides a summary of various environmental data (elevations, aspects, and slope positions) for each of the major vegetation types of the watershed. The four variants of the *"Acer saccharum/Smilacina racemosa"* vegetation type and the two variants of the *"Acer saccharum-Betula lutea/Taxus canadensis"* have been included.

The types are arranged according to their mean elevations, but it can also be seen from Table 5 that vegetation type seems to correlate well with slope position and mean elevation. Based on this relationship three broad zonations can be recognized within the watershed. The vegetation types in Zone 1 are found on crest and upper slope positions at elevations greater than 450 m. In Zone 2, vegetation types are linked to middle and lower slope positions within the elevation range 400-450 m. In Zone 3, vegetation types are associated with lower slope or wetland positions at elevations of less than 400 m.

From the mean elevation ranges associated with the vegetation types in Table 5, it is evident that although the vegetation types may dominate in certain elevation zones and on certain slope positions, they are by no means exlusive to that zone. For example, where a given vegetation type occurs in the upper elevation range of Zone 2 and in the lower elevation range of Zone 1 their respective slope positions are different. Conversely, the same vegetation types are very seldomly found in the same slope positions in different zones. To illustrate this point, Zone 1 crest positions are generally dominated by *"Acer saccharum/Aralia nudicaulis"* and *"Acer saccharum/Rubus allegheniensis"* vegetation types. In Zones 2 and 3, the crest positions are more likely to be dominated by the *"Acer rubrum"* variant of the *"Acer saccharum/ Smilacina racemosa"* vegetation type, and only occasionally by the *"Acer saccharum/ Rubus allegheniensis* type. On upper slope positions in Zone 1 the *"Acer saccharum/ Aster macrophyllus"* and *"Acer saccharum/ Cornus alternifolia"* vegetation types are most frequently found. In Zone 2, however, on these same upper slope positions the *"Maianthemum"* variant of the *"Acer saccharum/Smilacina racemosa"* vegetation type is more likely to occur with the *"Acer rubrum"* variant of the *"Acer saccharum/Smilacina racemosa"* vegetation type occurring in infrequent cases. Differences in micro-climate and other site factors such as moisture and slope contribute to these variations.

### 4.3.2 Soil-Environment Relationships

Using data collected during the mapping phase of the project, a summary of the percent occurrence between soil types and slope positions in the watershed was prepared (Table 6). From the summary, it is evident soil type-slope position relationships are not well defined. Soil type-elevation and aspect correlations showed similarly poor relationships.

Although soil type/slope-elevation-aspect relationships are not highly correlated, some trends are evident. For example, upper slope positions are most frequently associated with silt loam/silt loam (S5) and loamy sand-silt loam/sand-silt loam (S3) types. Middle slope positions tend to be dominated by loam-silt loam/loam-silt loam (S4) and silt loam/silt loam (S5) types. A relatively wide range of soil conditions are associated with crest and lower slope positions.

### 4.3.3 Soil-Vegetation Relationships

The vegetation-soil relationships were

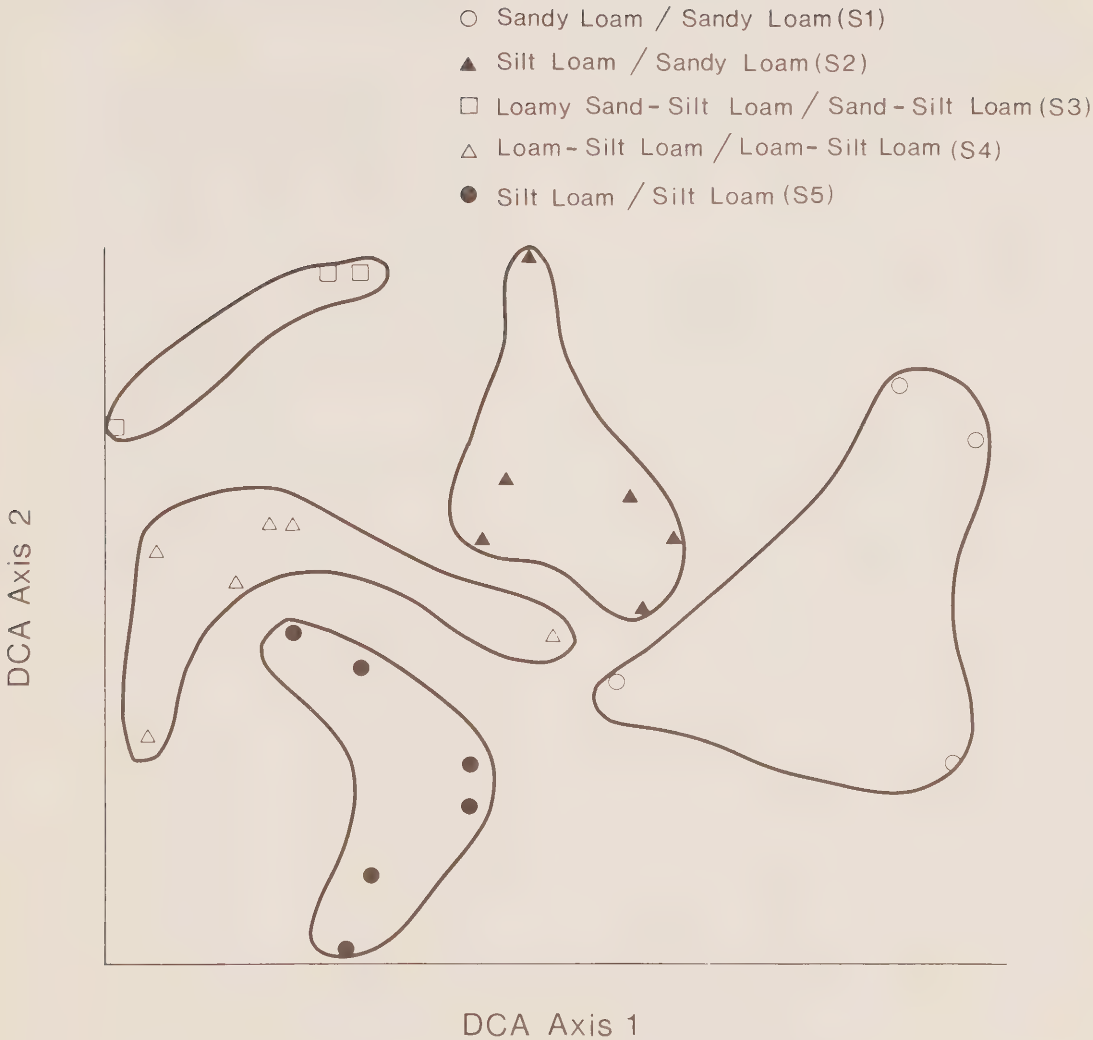



**FIGURE 6:**
**ORDINATION OF 25 MINERAL SOIL STANDS (FIRST TWO AXES) IN THE TURKEY LAKES WATERSHED USING CORRESPONDENCE ANALYSIS.**

In naming the soil types, textures to the left of the slash are surface soil (0-25 cm) conditions, textures to the right of the slash are those of the parent material

TABLE 5: SUMMARY OF THE ELEVATIONS, ASPECTS, AND SLOPE POSITIONS BY MAJOR VEGETATION TYPE OF THE TURKEY LAKES WATERSHED

| Zone | Vegetation type | Mean Elevation (Meters a.s.l.) | Elevation Range (m) | Mean Elevation Zone | Aspect | Dominant Slope Position |
|---|---|---|---|---|---|---|
| ZONE 1 | *Juniperus communis/Vaccinium myrtilloides* [n=1] | 624 | - | | W | Crest |
| | *Picea glauca-Betula papyrifera-Sphagnum girgensohnii* [n=1] | 500 | - | | - | Depression |
| | *Acer saccharum/Aster macrophyllus* [n=4] | 500 | 475-515 | | W | Upper |
| | *Acer saccharum/Aralia nudicaulis* [n=5] | 486 | 424-519 | | S-SW | Crest |
| | *Acer saccharum/Smilacina racemosa (Acer rubrum* variant) [n=15] | 473 | 400-525 | | NE-W | Upper-Crest |
| | *Acer saccharum/Cornus alternifolia* [n=4] | 471 | 454-480 | 467 m | E-SW | Upper-Middle |
| | *Acer saccharum/Rubus allegheniensis* [n=6] | 459 | 430-518 | ( > 450 m) | N-NE-S | Crest-Upper |
| | *Acer saccharum/Impatiens capensis* [n=2] | 442 | - | | - | Depression |
| | *Acer rubrum-Thuja occidentalis/ Quercus rubra* [n=4] | 441 | 369-503 | | E-NE | Cliff-Upper and Cold Air Drainage on Middle and Lower Slope Positions. |
| ZONE 2 | *Acer saccharum/Smilacina racemosa (Maianthemum* variant) [n=12] | 439 | 381-522 | | N-NE | Middle-(Upper) |
| | *Acer saccharum/Athyrium felix-femina* [n=4] | 438 | 386-490 | | N | Upper-Middle |
| | *Acer saccharum/Betula lutea/Taxus canadensis (Taxus* variant) [n=25] | 433 | 357-509 | | N-NE-(SW) | Middle-Lower-(Upper) |
| | *Acer saccharum/Smilacina racemosa* (Shrub-rich variant) [n=60] | 431 | 369-515 | 425 m | S-SW-NE | Middle-Upper |
| | *Acer saccharum/Smilacina racemosa* (Herb-rich variant) [n=20] | 416 | 390-454 | (400-450 m) | N-NE | Middle-Upper |
| | *Abies balsamea/Dryopteris spinulosa* [n=1] | 415 | - | | W | Draw/Seepage |
| | *Acer saccharum-Ostrya virginiana/Mitchella repens* [n=4] | 405 | 393-424 | | S-W-N | Upper-Middle-Lower |
| ZONE 3 | *Picea glauca/Vaccinium ovalifolium* [n=2] | 387 | - | | W | Lower-(Middle) |
| | *Fraxinus nigra/Osmunda regalis-Onoclea sensibilis* [n=2] | 381 | - | | - | Lower/Wetland |
| | *Fraxinus nigra/Sphagnum cuspidatum* [n=2] | 381 | - | | - | Lower/Wetland |
| | *Picea glauca-Betula lutea/Taxus canadensis (Thuja* variant) [n=5] | 370 | 357-381 | 374 m | N-W | Lower/Toe |
| | *Larix laricina/Alnus rugosa* [n=1] | 345 | - | ( < 450 m) | - | Lower/Wetland |

evaluated in a fashion similar to the method used for the soil-environment relationships. Data collected from the 420 stands sampled during the mapping phase were used to examine the soil-vegetation relationships. These results are presented in Table 7. In this Table, the vegetation types have been arranged according to their dominant slope position and elevation - similar to that presented in Table 5. Soil types have also been grouped using the ordination results (Figure 6) and information presented in Table 8.

From Table 8 it can be seen that soil Group 1 has the thickest "L" and "F" surface organic horizons (as a percentage of the total depth of the "LFH" layer). Similarly, the thinnest rooting zones are associated with soil Group 1 and the thickest with soil Group 2. Soil Group 3 is an organic soil group. Further detailed discussion of the soil-vegetation relationships is provided in the following section of the report.

# 5.0 DESCRIPTION OF FOREST VEGETATION TYPES

## 5.1 Upland Hardwood Types

### 5.1.1 *Juniperus communis/Vaccinium myrtilloides* Vegetation Type

The *"Juniperus communis/Vaccinium myrtilloides"* vegetation type is found at only one location in the watershed - the top of Batchawana Mountain at 624 m a.s.l. The community is found on sandy-silty loam textured soil which is developed in a stony, shallow till (soil type 1). The site is exposed to strong winds and storms in winter and warmer than normal conditions during the summer. These conditions are probably the most important factors in maintaining the vegetation type. Scattered low (.5 - 1 m) and tall (2 - 10 m) shrubs *(Thuja occidentalis, Crataegus* spp.*)* with a dense cover of *Calamagrostis canadensis* (Michx.) Beauv. are developed over a gramino raw moder humus form. Other species of some significance belonging to the type include: *Rubus strigosus* Michx., *Prunus pensylvanica* L.f., *Rubus allegheniensis* Porter., *Corylus cornuta* Marsh., *Ribes glandulosum* Grauer., and *Rosa acicularis* Lindl.

### 5.1.2 *Acer saccharum/Aralia nudicaulis-Rubus strigosus* Vegetation Type

Located mainly in the upper elevation areas, Zone 1, of the watershed (mean elevation 486 m a.s.l.), the *"Acer saccharum/Aralia nudicaulis-Rubus strigosus"* vegetation type is commonly found on crest or upper slope landscape positions. Soils are a generally stony, and shallow (< 1.0 m) silt loam/sandy loam-silt loam (soil type 2)[1], with fibrimor-fibrihumimor humus forms. Stands of this type are generally more open and tree heights are reduced (13-18 m), due to the shallow soil

TABLE 6: PERCENT OCCURRENCE OF THE 6 MAJOR SOIL TYPES VS. SLOPE (LANDSCAPE) POSITION IN THE TURKEY LAKES WATERSHED

| Soil Type * | Slope Position | | | | |
|---|---|---|---|---|---|
| | Crest | Upper | Middle | Lower | Bottomland/ Wetland |
| S1 (n=9) | 11 | 44 | 11 | 33 | - |
| S2 (n=17) | 18 | 53 | 22 | 33 | - |
| S3 (n=38) | 21 | 40 | 21 | 18 | - |
| S4 (n=55) | 29 | 24 | 29 | 16 | 2 |
| S5 (n=64) | 16 | 45 | 23 | 14 | 2 |
| S6 (n=12) | - | - | 8 | 17 | 75 |

* The six soil types are those recognized in Figure 3.

1 In some areas, soil types S4 and S5 may also occur.

TABLE 7: PERCENT OCCURRENCE OF THE 6 MAJOR SOIL TYPES IN RELATION TO THE 17 MAJOR VEGETATION TYPES IN THE TURKEY LAKES WATERSHED.

| | | DOMINANT SLOPE/LANDSCAPE POSITION | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Crest-Upper | | | | | | Middle-Lower | | | | | | | | Lower | | | | | |
| | Vegetation Type | V1 | V2 | V4 | V5 | $V6_4$* | V17 | $V6_1$* | $V6_2$* | $V6_3$* | V3 | V8 | V9 | V10 | V11 | V7 | V12 | V13 | V14 | V15 | V16 |
| Soil Group# 1 | Soil Type 1 (n=66) | - | 14 | - | - | - | 1 | 40 | 18 | 5 | 1 | - | 3 | 1 | 18 | - | - | - | - | - | - |
| | Soil Type 2 (n=17) | 6 | 12 | - | - | - | - | 35 | 12 | - | - | - | 6 | 6 | 24 | - | - | - | - | - | - |
| Soil Group 2 | Soil Type 3 (n=47) | - | 4 | - | - | - | - | 47 | 19 | 4 | 2 | - | 11 | 2 | 13 | - | - | - | - | - | - |
| | Soil Type 4 (n=79) | 1 | 4 | - | 3 | 11 | - | 27 | 15 | 4 | 1 | 1 | 19 | 1 | 13 | - | - | - | - | - | - |
| | Soil Type 5 (n=92) | 1 | 3 | 1 | 1 | 8 | - | 45 | 10 | 10 | 1 | 1 | 9 | 2 | 9 | - | - | - | - | - | - |
| Soil Group# 3 | Soil Type 6 (n=12) | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 8 | 17 | 33 | 17 | 8 | 17 |

# Soils types 1 and 2 (Group 1): -Thickest Land F (as % of LFH)
-Thinnest H (as % of LFH)
-Thinnest rooting zone (as % of Pedon)

Soil type 6 (Group 3): Organic soil

* Names of the vegetation types are provided in Figure 2. Vegetation type 6 has been subdivided as follows:

$V6_1$ : Shrub-rich variant
$V6_2$ : Herb-rich variant
$V6_3$ : *Maianthemum canadense* variant
$V6_4$ : *Acer rubrum* variant

In addition, vegetation types V16 and V17 are as follows:

V16 : *Juniperus communis/Vaccinium myrtilloides*
V17 : *Acer saccharum/Impatiens capensis*

TABLE 8: CHARACTERISTICS OF SELECTED SOIL ATTRIBUTES FOR THE SIX MAJOR SOIL TYPES[1] IN THE TURKEY LAKES WATERSHED.

| | | Group 1 | | Group 2 | | | Group 3 |
|---|---|---|---|---|---|---|---|
| | | S1 | S2 | S3 | S4 | S5 | S6 |
| Surface Organic Horizons 1 | Depth LFH (% Profile) | 3 | 3 | 3 | 5 | 13 | - |
| | Thick L (% of LFH) | 28 | 15 | 13 | 13 | 15 | 18 |
| | Thick F (% of LFH) | 53 | 58 | 43 | 43 | 43 | - |
| | Thick H (% of LFH) | 8 | 15 | 33 | 33 | 33 | - |
| Mineral Horizons 2 | Thick Ahe (% Profile) | 3 | 5 | 3 | 3 | 8 | - |
| | Thick Bhf (% Profile) | 3 | 33 | 28 | 28 | 15 | - |
| | Thick Bf (% Profile) | 55 | 18 | 28 | 35 | 68 | - |
| Rooting Zone 3 | Thick Root (% Profile) | 28 | 53 | 58 | 78 | 73 | 23 |

[1] Six major soil types are those recognized in Figure 3.

conditions and the more severe micro-climate conditions of its landscape position. The occurrence of the *Acer saccharum, Rubus strigosus* and *Cinna latifolia* (Trev.) Griseb. species groups is used to define this type. Dominant understory shrub and herb species include: *Ribes glandulosum, Ribes triste* Pall, *Prunus virginiana* L., *Polygonum cilinode* Michx., *Ulmus americana L., Cinna latifolia, Aralia nudicaulis* L., *Acer rubrum,* and *Acer saccharum.*

### 5.1.3 *Acer saccharum/Rubus allegheniensis* Vegetation Type

Although similar to the *"Acer saccharum/Aralia nudicaulis-Rubus strigosus"* type in that it is also found on crest or upper slope positions, the *"Acer saccharum/Rubus allegheniensis"* community generally occurs at somewhat lower elevations in the watershed (mean elevation 459 m a.s.l.) and with north-east aspects. This type occurs predominantly on loamy soil (soil type 1) which has developed in stony till. Fibrimor is the dominant humus form. The *"Acer saccharum", "Rubus allegheniensis", "Polygonatum biflorum"* and *"Streptopus roseus"* species groups all occur in this type. Dominant shrub and understory herb species include: *Rubus allegheniensis, Polygonatum biflorum* (Walt.) Ell., *Smilacina racemosa* (L.) Desf., *Streptopus roseus* Michx., *Dryopteris spinulosa* (Mull.) Fiori., *Sorbus decora* (Sarg.) C.K. Schneid, *Quercus rubra,* and *Acer rubrum.*

### 5.1.4 *Acer saccharum/Athyrium filix-femina* Vegetation Type

*"Acer saccharum/Athyrium filix-femina"* is a middle elevation, Zone 2, type (mean elevation 438 m a.s.l.), which usually occur on middle-upper slopes with northerly aspect positions. Soil textures range from silt to loam to loamy sand to sand (soil types 1, 3, 4, 5) which have developed in the stony till. Fibrimor is the dominant humus form.

The *"Acer saccharum", "Smilacina racemosa", "Streptopus roseus"* species

groups are characteristic of this type. *Athyrium filix-femina* (L.) Roth is part of the *"Smilacina"* group, and is the dominant herb. Other shrub and herb species of significance include: *Sambucus pubens* Michx., *Betula lutea, Sorbus decora,* and *Polygonum cilinode*.

### 5.1.5 *Acer saccharum/Aster macrophyllus* Vegetation Type

An upper elevation, Zone 1, type (mean elevation 500 m a.s.l.), *"Acer saccharum/ Aster macrophyllus"* occurs predominantly on west facing upper slope positions. On the basis of only one soil pit within this type, the soil was found to be a silt loam/silt loam (soil type 5) in a stony compact till, with a fibrihumimor humus form. The *"Acer saccharum"*, *"Polygonatum biflorum"* and *"Streptopus roseus"* species groups are used in differentiating this vegetation type. Other herb and shrub species are: *Rubus allegheniensis, Ostrya virginiana, Lycopodium lucidulum, Betula lutea, Dryopteris spinulosa* and *Smilacina racemosa*.

### 5.1.6 *Acer saccharum/Cornus alternifolia* Vegetation Type

*"Acer saccharum/Cornus alternifolia"* is an upper elevation, Zone 1, vegetation type (mean elevation 471 m a.s.l.) occurring on upper-middle slope positions with variable aspects. Soils are mainly loam-silt loam in both surface and subsurface conditions (soil type 4) and are developed in stony till with a fibri-humimor humus form. Species groups similar to those characterizing the *"Acer saccharum/Aster macrophyllus"* type also characterize this type. These include: the *"Acer saccharum"*, *"Polygonatum biflorum"* and *"Streptopus roseus"* species groups. *Cornus alternifolia* differentiates these two groups as it occurs only in this vegetation type. *Aster macrophyllus* L. can occasionally occur (30% of sites). Other herb and shrub species which are present include: *Cinna latifolia, Rubus allegheniensis, Smilacina racemosa, Dryopteris spinulosa, Betula lutea, Lycopodium lucidulum,* and *Acer rubrum*.

### 5.1.7 *Acer saccharum/Smilacina racemosa* Vegetation Type

The *"Acer saccharum/Smilacina racemosa"* vegetation type is the most frequently occurring and spatially dominant type in the watershed. On the basis of detailed stand sampling in 1981, it was generally found to occur on middle-upper slope positions of variable aspect. Soil conditions ranged from loamy sand to silt loam (S1 to S5) with a fibrimor humus form. *Betula lutea* occasionally occurred in the tree layer, but infrequently as a co-dominant. Other common herb and shrub species include: *Polygonatum biflorum, Ostrya virginiana, Smilacina racemosa, Dryopteris spinulosa, Lycopodium lucidulum, Trientalis borealis,* and *Acer rubrum*.

More intensive sampling during the summer of 1982 mapping program suggested that although the general description for this type was adequate, a number of "variants" could be recognized which would help to better define the wide ranging conditions originally described. Since detailed stand sampling was not carried out, descriptions of the variants are necessarily subjective and brief.

#### (i) Shrub-rich variant

The shrub-rich variant is the most ubiquitous of the variants, occurring over a wide range of elevations (369-515 m a.s.l.), slope positions, aspects, and soil conditions. The vegetation density is high, dominated by *Acer saccharum* in all strata. The herb layer is sparse, dominated by *Smilacina racemosa* and *Polygonatum biflorum*.

#### (ii) Herb-rich variant

The herb-rich variant occurs primarily on middle to upper slope positions in the lower portion of the watersheds. Its elevational range is more restricted (390-454 m a.s.l.), as is its aspect (N-NE). Soil conditions are variable, ranging from loamy sands to silty loams. The herb layer is dominated by *Streptopus roseus, Smilacina racemosa* and *Dryopteris spinulosa*. Scattered shrubs are primarily *Acer saccharum*. On the upper slope positions *Aralia nudicaulis* and *Rubus allenghenienses* may also occur. The sparse cover and the usual occurrence of *Lycopodium lucidulum*, however, prevents the type from being keyed to either the *"Acer saccharum/Rubus allegheniensis"* or *"Acer saccharum/Aralia nudicaulis"* vegetation types.

#### (iii) *Maianthemum canadense* variant

This variant is similar to the herb-rich variant in that the shrub layer is sparse,

and has similar slope, aspect, elevational range and soil conditions. The *Maianthemum* or boreal variant, however, is often associated with cold air drainage or frost pocket conditions, or wetter conditions (e.g. moisture regime 4-5 according to the Ontario physiographic site classification system). The deciduous shrub layer is sparse and dominated by *Acer saccharum*. *Taxus canadensis* is usually present as a coniferous low shrub. Dominant herb species include *Clintonia borealis*, *Trientalis borealis* and *Maianthemum canadense* Desf. with *Lycopodium lucidulum* as the dominant moss.

**(iv) *Acer rubrum* variant**

The *Acer rubrum* variant, with mean elevations of 473 m a.s.l., includes *Ostrya virginiana* in the tree layer, occurs almost exclusively on crest and upper slope positions in the low parts of the watershed with loam- silt loam soils (soil type 4 and 5). It appears to replace the *"Acer saccharum/Rubus allegheniensis"* type which occurs on the same slope position in the upper parts of the watershed. Dominant shrub and herb species include: *Acer rubrum*, *Acer saccharum*, *Smilacina racemosa*, *Carex intumescens* Rudge., *Aralia nudicaulis*, *Streptopus roseus*, *Rubus allegheniensis*, *Betula lutea*, and *Dryopteris spinulosa*.

## 5.2 Upland Mixedwood Types

### 5.2.1 *Picea glauca/Vaccinium ovalifolium* Vegetation Type

*"Picea glauca/Vaccinium ovalifolium"* is a lower slope vegetation type (mean elevation 387 m a.s.l.), occurring on level sites adjacent to streams and creeks or near lakeshores. Such sites are often associated with cooler microclimate conditions resulting from either cold air drainage e.g. near creek beds or proximity to open water. The presence of such boreal elements as *Coptis trifolia*, *Maianthemum canadense*, *Clintonia borealis*, *Acer spicatum* Lam. and *Corylus cornuta* lend some weight to this interpretation. Soil texture is mainly loam and silt loam (soil types 4 and 5) with deciduo-conifer fibri-humimor humus form. Soils may be gleyed or prominantly mottled within the control section. The *"Acer saccharum"* and *"Acer spicatum"* and *"Thuja occidentalis"* (shrub layer) species groups characterize this vegetation type. The *"Streptopus roseus"* and *"Corylus cornuta"* species groups also occurs (in 50-66% of stands within this type). Canopy species include: *Picea glauca*, *Betula lutea*, *Abies balsamea* (L.) Mill., *Thuja occidentalis*, *Acer saccharum* and occasionally *Betula papyrifera* Marsh. Other frequently occurring herb, lichen, moss, and shrub species include *Aralia nudicaulis*, *Betula lutea*, *Lycopodium lucidulum*, *Trientalis borealis*, *Acer rubrum*, *Abies balsamea*, and *Lonicera canadensis*.

### 5.2.2 *Acer saccharum-Betula lutea/Taxus canadensis* Vegetation Type

*"Acer saccharum-Betula lutea/Taxus canadensis"* is one of the more frequently occurring vegetation types in the watershed. Detailed stand sampling in 1981 yielded a description of this upland type. It occurs on middle to lower slopes of north-northeast aspect with fresh, sand to silt loam on stony till and with humi-fibrimor humus forms (soil types 1 to 5). The type is characterized by the presence of two species groups, the *"Acer saccharum"* and *"Viola cucullata"* groups. The *"Corylus cornuta"* group occurs frequently (50-60%) as well. The type is dominated by the presence of numerous boreal species including: *Clintonia borealis*, *Maianthemum canadense*, *Taxus canadensis*, *Corylus cornuta*, and *Acer spicatum*. *Picea glauca* and *Abies balsamea* are significant understory shrub components. *Vaccinium ovalifolium* and *Cornus alternifolia* occur infrequently.

Further sampling during the 1982 mapping program suggested that a variant of this type occurred on lower, wetter (moisture regime 4-5) slope positions. It was decided to refer to this previously described variant as the *"Taxus canadensis"* variant, and the lower slope position community, the *"Thuja occidentalis"* variant. In this latter community, the *Thuja* essentially replaces the *Taxus* in the shrub layer, and it may also occur in the tree layer on particularly moist sites. The tree layer is, therefore, characterized by *Acer saccharum*, *Betula lutea* and *Thuja occidentalis*. In the shrub layer, *Lonicera canadensis* Marsh., *Acer spicatum*, *Acer saccharum*, *Thuja occidentalis*, *Betula lutea*, *Corylus cornuta*, *Picea glauca*, *Abies balsamea* and *Sorbus americana* Marsh. are common. Dominant herbs include: *Clintonia borealis*, *Dryopteris spinulosa*, *Cinna latifolia*, *Thelypteris phegopteris* (L.) Slosson., *Streptopus roseus*, *Trientalis borealis* and *Maianthemum candense*.

### 5.2.3 *Acer saccharum-Ostrya virginiana/ Mitchella repens* Vegetation Type

The *"Acer saccharum-Ostrya virginiana/ Mitchella repens"* vegetation type occurs on upper-middle to lower slopes (405 m a.s.l.) with variable aspects. Soil textures range from loamy sand to silt loam, types S1 to S5 in this type. *Ostrya virginiana* has its best expression in this type. Other dominant canopy species include *Acer saccharum, Betula lutea,* and *Thuja occidentalis.* Major herb and shrub species in this relatively sparsely populated type include *Mitchella repens* L., *Abies balsamea, Trientalis borealis, Dryopteris spinulosa, Smilacina racemosa,* and *Streptopus roseus.*

### 5.2.4 *Acer rubrum-Thuja occidentalis- Quercus rubra* Vegetation Type

The *"Acer rubrum-Thuja occidentalis-Quercus rubra* type occurs from 369 to 503 m a.s.l. primarily on two slope positions: a) along cliff edges with northerly or westerly aspects and exposed crest positions (cliff edges often nearby), and b) on middle-lower slope positions with cold air drainage or frost pockets. Somewhat harsher micro-climate conditions may be associated with these slope positions and the shallow soil depth over bedrock result in a slightly fresher moisture regime, particularly during spring melt and heavy rainfall periods. Soil texture ranges from loamy sand to silty loam on a shallow, stony till. Fibri-humimor is the dominant humus form. In addition to the distinct forest cover, the type is differentiated by the *"Acer saccharum", "Sorbus decora-Acer rubrum"* and *"Thuja occidentalis"* (shrub) species groups. Dominant herbs and shrubs include: *Acer rubrum, Sorbus decora, Maianthemum canadense, Clintonia borealis, Abies balsamea* and *Picea glauca. Pinus strobus* is often a co-dominant canopy species in those stands adjacent to cliff edges.

This vegetation type can, under certain site conditions, occur with the *"Picea glauca/Vaccinium ovalifolium"* type. A number of stands on the bedrock knobs adjacent to the upper lake in the watershed, for example, were "keyed" (using TWINSPAN) to the *"Acer rubrum-Thuja occidentalis- Quercus rubra"* vegetation type, although there was generally a significant affinity to the *"Picea glauca/Vaccinium ovalifolium"* vegetation type. On these bedrock sites, the tree layer was characterized by *Picea glauca, Thuja occidentalis, Acer rubrum, Abies balsamea* and *Pinus strobus.* Understory species included *Epigaea repens* L. (the only location in the watershed where this species was observed), *Vaccinium myrtilloides* Michx., *Vaccinium ovalifolium* Smith, *Pteridium aquilinum* (L.) Kuhn., *Vaccinium angustifolium* A. t., *Ledum groenlandicum* Oeder., *Maianthenum canadense, Coptis trifolia* and *Clintonia borealis.*

## 5.3 Wetland Mixedwood Types

A total of six wetland vegetation types have been recognized as a result of the detailed stand sampling program. Because of their infrequent occurrence and low spatial representation throughout the watershed, sampling in these types was not intensive; in fact all 6 types here recognized are based on only one sample in each type. A number of additional wetland vegetation types were recognized during the mapping phase of this study. Brief floristic descriptions of these stands are provided in Section 6.5.

### 5.3.1 *Fraxinus nigra-Osmunda regalis-Onoclea sensibilis* Vegetation Type

The *"Fraxinus nigra-Osmunda regalis- Onoclea sensibilis"* type is located in a shallow depression at elevation 381 m a.s.l. *Fraxinus nigra, Picea glauca,* and *Betula lutea,* dominate in the canopy with *Sorbus decora* and *Ostrya virginiana* and *Pinus strobus* also present. The soil is a well humified (Von Post 8) organic (Terric Humisol), approximately 60 cm in depth, overlaying a gleyed loamy sand substrate. This vegetation type is dominated by the ferns *Onoclea sensibilis* L. and *Osmunda regalis* L. The herbs *Carex trisperma* Dewey., *Eupatorium maculatum* L., and *Impatiens capensis* Meerb. also occur. Two sphagnum mosses, *S. cuspidatum* Ehrh. ex Hoffm. and *S. magellanicum* Brid. and one feathermoss, *Ptilium crista-castrensis* (Hedw.) De Not. are dominant in the moss layer.

### 5.3.2 *Picea glauca-Betula papyrifera/ Sphagnum girgensohnii* Vegetation Type

The *"Picea glauca-Betula papyrifera/ Sphagnum girgensohnii"* vegetation type is found in a seepage zone (intermittent creek) on relatively level terrain at elevation 500 m a.s.l. Although *Picea glauca* and

*Betula papyrifera* are dominant in the stand, *Abies balsamea, Acer rubrum,* and *Betula lutea* are also present. In the shrub and herb layers, *Acer spicatum, Abies balsamea, Thuja occidentalis, Osmunda cinnamomea* L., *Carex trisperma, Cornus canadensis, Clintonia borealis* are a significant component.

#### 5.3.3 *Fraxinus nigra/Sphagnum cuspidatum* Vegetation Type

The *"Fraxinus nigra/Sphagnum cuspidatum"* type is found in a relatively large depression (.5-1.0 ha) at 381 m a.s.l. with organic soil. *Fraxinus nigra* and *Thuja occidentalis* are the dominant tree species with *Acer rubrum, Acer spicatum, Osmunda regalis, Osmunda cinnamonea, Onoclea sensibilis, Carex trisperma* and *Viola cucullata* Ait. as the dominant understory shrub and herb species. *Sphagnum cuspidatum* and *Mnium pseudopunctatum* Bruch & Schimp. are dominant moss species.

#### 5.3.4 *Abies balsamea/Dryopteris spinulosa* Vegetation Type

Found in the lower portion of the watershed (415 m a.s.l.), the *"Abies balsamea/ Dryopteris spinulosa"* type occurs in zones of significant seepage (stream beds) with a well-developed "Oh" horizon throughout the profile (Von Post decomposition: 8). The canopy species are dominated by *Abies balsamea, Betula lutea* and *Thuja occidentalis*. *Ostrya virginiana* is also being present. Dominant shrub and herb species include *Picea glauca, Acer spicatum, Athyrium filix-femina, Dryopteris spinulosa, Eupatorium maculatum, Equisetum sylvaticum* L., and *Carex leptalea* Wahl.

#### 5.3.5 *Larix laricina/Alnus rugosa* Vegetation Type

The *"Larix laricina/Alnus rugosa"* type occurs adjacent to the main outlet stream from the watershed at elevation 345 m a.s.l. A thin conifero-humic Peaty mor humus form overlies 120 cm of well-humified (Von Post decomposition: 8) organic material. Although *Larix laricina* dominates in the overstory, *Picea glauca, Betula papyrifera* and *Thuja occidentalis* also occur. Dominant shrub and herb species include: *Acer spicatum, Alnus rugosa* (DuRoi) Spreng., *Sorbus americana, Corylus cornuta, Lonicera canadensis, Acer saccharum, Clintonia borealis, Coptis trifolia* and *Carex trisperma*. Numerous other herb species in a sparse cover occur in the type.

A slightly wetter phase of this type can occur where *Alnus rugosa* is somewhat denser and *Sphagnum girgensohnii* Russ. more abundant.

#### 5.3.6 *Acer saccharum/Impatiens capensis* Vegetation Type

The *"Acer saccharum/Impatiens capensis"* type is found with organic soil in a depression at 442 m a.s.l. *Acer saccharum* dominates in the canopy. Dominant understory herb species include *Impatiens capensis, Athyrium filix-femina* and *Athyrium thelypteroides* (Michx.) Desv.

## 6.0 MAPPING OF VEGETATION AND SOIL TYPES OF THE WATERSHED

Mapping the forest ecosystems of the watershed was carried out to demonstrate the spatial distribution of the various vegetation and soil types which were identified during the classification phase of the project. Three distinct tasks were recognized as part of the mapping program:

1) Delineation of map polygons.
2) Defining the map unit types; i.e. recurring combinations of vegetation and soil types over the landscape (legend development).
3) Allocation of the map polygons to one of the defined map unit types.

### 6.1 Delineation of Map Polygons

A total of 125 map polygons in the watershed were delineated using 1:12 000 scale black and white panchromatic aerial photos. Landform and vegetation appearance were the most significant features used in identifying and delineating the polygons. Once the watershed was subdivided, each polygon was given a unique number for future reference.

The point intercept method or point transect method (Wang, 1982) was used for collecting field data which was used subsequently for building the taxonomic map units (legend development) and allocating the polygons to a particular map unit type. Although it would have been preferable to undertake the legend development and the allocation phases separately, time constraints necessitated the amalgamation of the two phases. The method of field mapping/data collection described here is, therefore, a modified approach to the one described by Wang (1982).

Transects were selected on the basis of access (i.e. minimization of "dead heading"),

elevation range (i.e. to ensure all parts of the watershed were represented in rough proportion to their aerial extent), and distance that could be realistically mapped during an 8-10 hour period. A total of 16 transects through 51 polygons were completed which yielded field verification of approximately 45% of the polygons in the watershed. For each of the 51 polygons, 8-10 observations were made at pre-selected chain intervals (the chain intervals varied depending on the size of the polygon in which the transect was located). In some smaller polygons the number of observations was less than 8, however, the minimum number of observations in any one polygon was 5.

The location of each transect was selected to maximize the potential variability in the polygon. It is recognized that in some of the larger polygons the number of observations is less than optimal but given the time constraints, the trade-off of the ideal sampling density was made to maximize the number of polygons visited. Such a trade-off was considered reasonable in view of the apparent homogeneity and predictability of the area, and the need for sampling a relatively large number of polygons for legend development.

### 6.2 Definition of the Map Unit Types

Following the data collection program, a summary matrix was developed and coded in a format which would be suitable for analysis using the TWINSPAN classification program (Hill, 1979). Each of the 51 polygons sampled was coded with the map polygons as the "stands" variable, and the soil and vegetation types, expressed as a percentage occurrence within the polygon, as the "species" variable in the program.

From the TWINSPAN analysis a classification key which defined a number of map unit types and their characteristic combinations of soil and vegetation types was developed (Figure 7).

This method of defining the map unit types is similar to that used previously for defining the vegetation and soil types. Whereas vegetation and soil types are defined by their diagnostic combinations of plant species or soil attributes, the map unit types are defined by diagnostic combinations of vegetation and soil types. Hence, each map unit type represents a similar and repetitive pattern of soil and vegetation landscape, which could be mapped at a scale of 1:12 000.

### 6.3 Allocation of Polygons

Following the identification of the map unit types, 47 of the 51 polygons (all upland sites) were classified into the map unit types using DECORANA (Figure 8). Polygons belonging to the wetland map unit type were excluded from the analysis in order to improve the ordination results for the upland polygons. As illustrated in Figure 8, the polygons clustered into relatively discrete groups. Axis 1 is thought to represent a complex of environmental factors relating primarily to slope position, aspect and elevation. Where map unit type 1, Batchawana, is dominated by crest position types primarily in the upper areas of the watershed, map unit 7, Norberg, is a lower slope position type found mainly in the lower part of the watershed. Interpretation of Axis 2 is difficult and appears, as in the previous ordinations, to be the result of an interplay amongst several physical and environmental factors which are difficult to consider independently.

Using the classification key developed in Section 6.2 the remaining 74 polygons were allocated to a map unit type based on data collected during the summer of 1982 by students employed at the Great Lakes Forest Research Centre. The data were gathered from field sampling, interpretation of 1:15 840 panchromatic aerial photographs and 1:4 000 35 m colour photographs taken over the watersheds. All the map unit type polygons are shown on Figure 9, with the 74 polygons, which were field checked, identified in the map legend (see map in back pocket of report).

### 6.4 Description of the Map Unit Types

#### 6.4.1 Upland Ecological Map Unit Types

**(i) Batchawana Map Unit Type (Ba)**

The Batchawana map unit type is a distinctive one. It dominates crest and upper slope positions at the highest elevational levels in the watershed. *"Acer saccharum-Rubus allegheniensis"* vegetation type is most common, although *"Acer rubrum-Thuja occidentalis-Quercus rubra"* occurs on more exposed sites and along cliff edges or on shallow soil sites. Coarse loamy soils (S1) are dominant, although soil types 2 to 5 and 9 (shallow over bedrock) also occur. This map unit occupies approximately 18 ha or 2% of the watershed.

**(ii) Algoma Map Unit Type (Al)**

The Algoma map unit type is dominated by

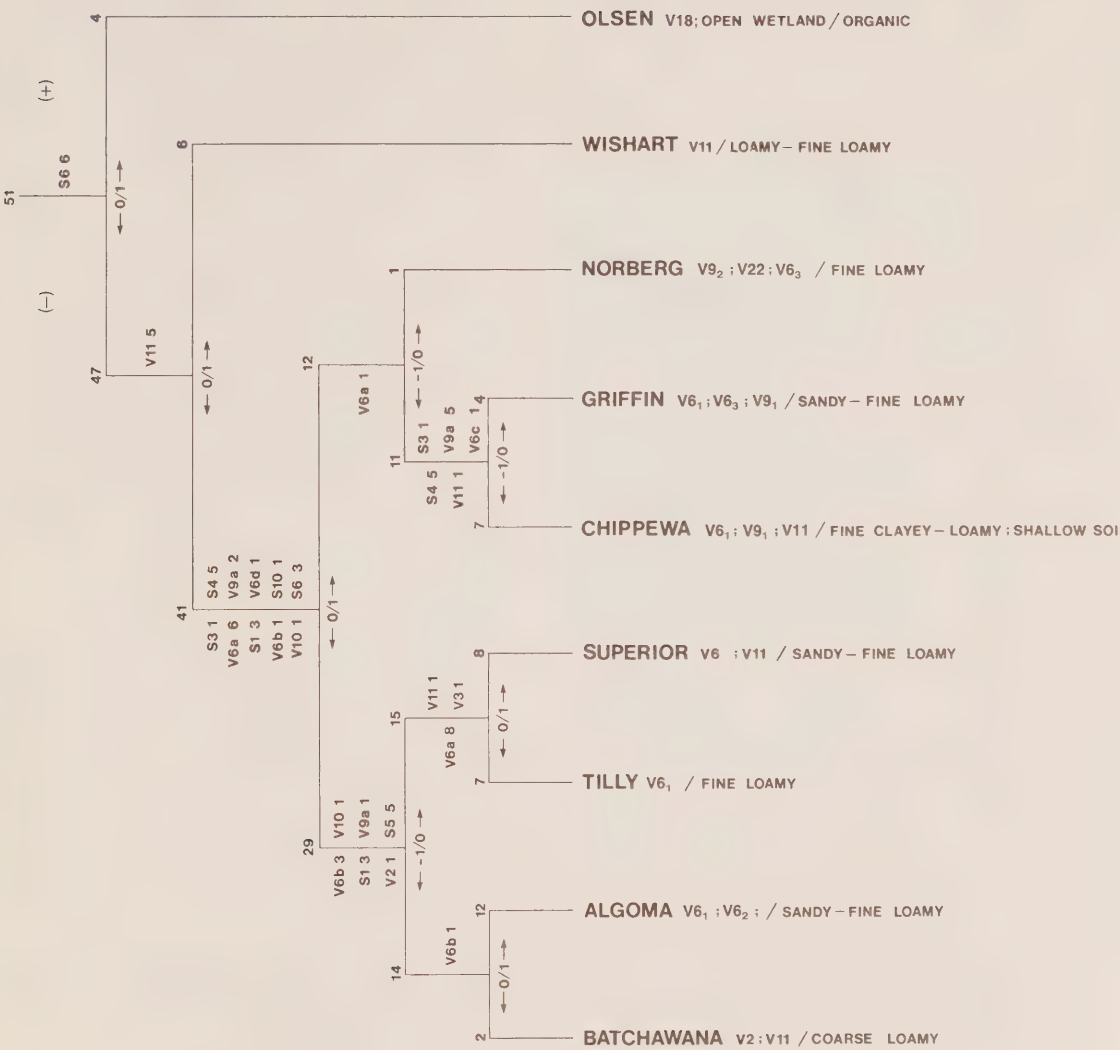



FIGURE 7: DENDROGRAM BASED ON TWINSPAN RESULTS FOR THE NINE MAP UNIT TYPES IN THE TURKEY LAKES WATERSHED.*

* All of the vegetation and soil types from the Watershed were used for each polygon description. The vegetation types are described in the legend of Figure 9 with V18 and V22 being described in Section 6.5 (f) and (d), respectively. Values after each indicator represent the percentage occurrence in that polygon (1 is 0.5–10%, 2 is 11–20%, 3 is 21–30%, 4 is 31–40%, 5 is 41–50%, 6 is 51–60%, 7 is 61–70%, 8 is 71–80%, 9 is over 80%).

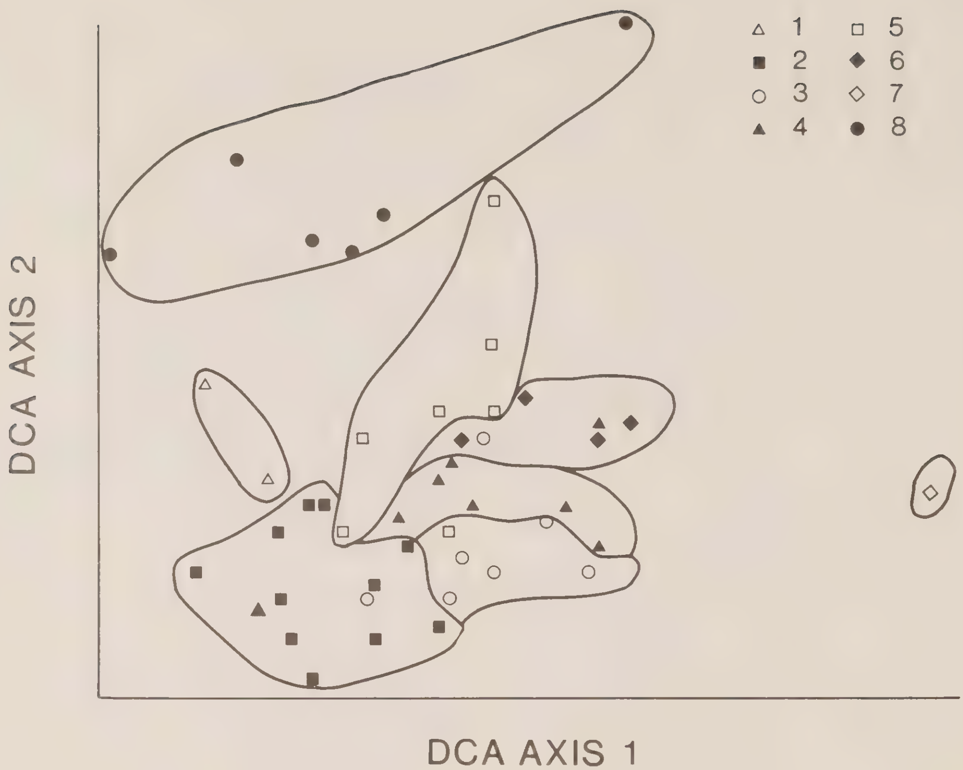



FIGURE 8: DETRENDED CORRESPONDENCE ANALYSIS ORDINATION (FIRST TWO AXES) OF THE MAP POLYGONS, SUBSEQUENTLY GROUPED BY MAP UNIT TYPE FOR THE TURKEY LAKES WATERSHED. 1=BATCHAWANA; 2=ALGOMA; 3=TILLY; 4=SUPERIOR; 5=CHIPPEWA; 6=GRIFFIN; 7=NORBERG; 8=WISHART; 9=OLSEN.

middle and upper slope position sites in the higher elevation areas (Zone 1) of the watershed; and on long, regularly sloping south and west facing slopes. The shrub-rich and herb-rich variants of the *"Acer saccharum-Smilacina racemosa"* vegetation type are common with some occurrence of the *Maianthemum* variant. Soil textures mostly are sand-fine loam (S1, S3-S5). The map unit occupies approximately 253 ha or 23% of the watershed.

**(iii) Tilly Map Unit Type (Ti)**

The Tilly map unit type is characterized by the full range of slope positions (upper-lower), although it is primarily found at lower and middle elevations (Zones 3 and 2). Topography is gentle to steeply rolling. The Tilly type is a relative pure unit with the shrub-rich variant of the *"Acer saccharum-Smilacina racemosa"* as the dominant vegetation type and silt loam/silt loam (S5) being the dominant soil type. This map unit occupies approximately 141 ha or 13% of the watershed.

**(iv) Superior Map Unit Type (Su)**

The Superior map unit type is characterized by steeply sloping, irregular topography and numerous cliffs. It is dominated by the *"Acer saccharum-Smilacina racemosa"* vegetation type which is commonly found on upper and middle slope positions whereas the less common *"Acer rubrum - Thuja occidentalis-Quercus rubra"* vegetation occurring on cliff sites. The *"Acer saccharum-Ostrya virginiana-Mitchella repens"* and the *"Acer saccharum-Athyrium filix femina"* vegetation types may also occur on upper slope positions. Soil textures range from sand to fine loam (S3, S4, S5). This map unit type occupies approximately 140 ha or 13% of the watershed, mainly in the area north of Turkey Lake.

**(v) Chippewa Map Unit Type (Ch)**

The Chippewa map unit type occurs extensively throughout the south and south-western parts of the watershed characterized by irregular and gradually sloping topography. A few large knobs and cliff edges are present. The shrub-rich and *Acer rubrum* variants of the *"Acer saccharum-Smilacina racemosa"* type as well as the *"Taxus canadensis* variant of the *"Acer saccharum-Betula lutea-Taxus canadensis"* vegetation types occur. Soils are usually fine loam textured (S4 and S5), with clay soils (S8) near lakeshore positions, and shallow soils (S9) along crests and near cliff landscape positions. This map unit type occupies approximately 307 ha or 28% of the watershed, primarily south of Turkey Lake.

**(vi) Griffin Map Unit Type (Gr)**

The Griffin map unit type is characterized by irregular topography. The shrub-rich variant of the *"Acer saccharum-Smilacina racemosa"* and the *"Taxus canadensis"* variant of the *"Acer saccharum-Betula lutea-Taxus canadensis"* vegetation types occur on the middle and lower slope positions with the *"Maianthemum"* variant of the *"Acer saccharum-Smilacina racemosa"* vegetation type occurring on the upper crest landscape positions. Soil textures range from sandy to fine loamy, soil types 4 and 5 being most dominant with soil types 3 and 7 also present. This map unit type occupies approximately 78 ha or 7% of the area.

**(vii) Norberg Map Unit Type (No)**

The Norberg map unit type is infrequently occurring yet distinctive within the watershed. The unit type primarily occupies lower slope positions with gently undulating topography and numerous seepage sites. It is dominated by the formally recognized *"Thuja"* variant of the *"Acer saccharum-Betula lutea-Taxus canadensis* vegetation type and by a number of other types which were informally recognized during the mapping stage of the program e.g. *"Thuja occidentalis-Betula lutea-Athyrium filix femina"* type and others in Section 6.5. Soils are generally fine loamy in texture with S5 being most dominant. Soil types S2 and S6 also occur in the unit. This map unit type occupies approximately 14 ha or 1% of the watershed.

**(viii) Wishart Map Unit Type (Wi)**

The Wishart map unit type is predominantly a lower and middle slope position type with seepage or shallow soil conditions. It is found in the upper parts of the watershed near Batchawana Lake and adjacent to the open wetland on the outlet stream from the watershed. The *"Acer rubrum-Thuja occidentalis-Quercus rubra"* vegetation type dominates, although the variants associated with the bedrock knobs near Batchawana Lake are somewhat different (see Section 5.2.4). Soils range from thin veneer over bedrock to loamy-fine loamy (S4) and (S1) textured materials. The map unit type occupies approximately 76 ha or 7% of the watershed.

### 6.4.2 Wetland Ecological Map Unit Type

#### (ix) Olsen Map Unit Type

The Olsen map unit type is a complex of open and treed wetlands, the latter being more prominent. The open wetlands, which occur along the major outlet stream from the watershed and adjacent to Batchawana Lake, are rich/poor fens dominated by various sedges and low shrubs (e.g. *Myrica gale*, *Salix* spp., *Chamaedaphne calyculata*) and deep organic soils. The treed wetlands are generally mixedwood swamps, characterized by a variety of vegetation types. The various wetland types sampled are described in the main text and in Section 6.5. A number of additional vegetation types were encountered but not sampled. This map unit type occupies approximately 63 ha or 6% of the watershed.

### 6.5 Preliminary Description of Additional Vegetation Types and Site Conditions

During the mapping phase of the project a number of stands were encountered which could not be allocated to one of the previously recognized vegetation types. Since replicates of these stands were not encountered, and because their floristic complements were only hastily noted, it was decided to include brief descriptions for general information only. Following are brief descriptions of these stands:

a) *Thuja occidentalis-Picea glauca/Thalictrum dasycarpum*
- Tree layer : *Thuja occidentalis, Betula lutea, Fraxinus nigra.*
- Shrub layer: *Alnus rugosa, Thuja occidentalis, Acer saccharum, Corylus cornuta, Acer rubrum, Acer spicatum, Lonicera canadensis, Picea glauca.*
- Herb layer : *Thalictrum dasycarpum, Osmunda regalis, Carex vaginata, Mitchella repens, Coptis trifolia, Thelypteris phegopteris, Equisetum sylvaticum, Mitchella repens, Athyrium filix-femina.*
- Soils : 22 cm Oh/stream gravel
- Slope Position : Lower/Basin

b) *Thuja occidentalis-Betula lutea/Osmunda cinnamomea*
- Tree layer : *Thuja occidentalis, Betula lutea, Pinus strobus, Acer saccharum.*
- Shrub layer: *Thuja occidentalis, Picea glauca, Corylus cornuta, Acer spicatum, Acer saccharum, Abies balsamea.*
- Herb layer : *Streptopus roseus, Osmunda cinnamomea, Cinna latifolia Carex vaginata, Coptis trifolia, Trientalis borealis, Carex disperma, Mitchella repens, Anemone quinquefolia, Pyrola secunda, Cornus canadensis.*
- Soils : Silty clay loam/fine-medium sand
- Slope Position : Lower slope position/Bottomland

c) *Acer saccharum-Betula lutea/Sorbus decora*
- Tree layer : *Acer saccharum - Betula lutea.*
- Shrub layer: *Acer saccharum, Acer spicatum, Fraxinus nigra, Corylus cornuta, Taxus canadensis, Lonicera canadensis, Abies balsamea, Picea glauca, Ribes triste, Rubus strigosus.*
- Herb layer : *Dryopteris spinulosa, Streptopus amplexifolius, Equisetum pratense, Galium triflorum, Carex vaginata, Mnium affine.*
- Soils : Organic
- Slope Position : Bottomland/Lower

d) *Betula lutea-Abies balsamea/Acer spicatum*
- Tree layer : *Thuja occidentalis, Picea glauca, Abies balsamea, Betula lutea.*
- Shrub layer: *Acer spicatum, Corylus cornuta, Betula lutea, Abies balsamea, Sambucus pubens, Ribes triste, Lonicera canadensis, Sorbus decora, Acer saccharum.*
- Herb layer : *Impatiens capensis, Athyrium felix-femina, Rubus pubescens, Viola spp., Thelypteris phegopteris, Habenaria orbiculata, Carex vaginata, Galium triflorum, Dryopteris spinulosa, Carex houghtonii.*
- Moss layer : *Mnium punctatum, Mnium affine, Meesia* spp.
- Soils : Organic
- Slope Position : Bottomland/Lower

e) *Fraxinus nigra-Acer saccharum/Calla palustris*

Tree layer : *Fraxinus nigra, Acer saccharum.*

Shrub layer: *Acer saccharum, Abies balsamea, Fraxinus nigra, Acer spicatum, Corylus cornuta.*

Herb layer : *Equisetum sylvaticum, Calla palustris, Impatiens capensis, Galium asprellum, Rubus pubescens, Trillium cernuum, Prunella vulgaris, Eupatorium maculatum, Osmunda cinnamomea, Cinna latifolia, Thelypteris phegopteris, Clintonia borealis, Athyrium filix-femina, Carex houghtonii.*

Soils : Organic

Slope

Position : Bottomland/Lower

f) *Chamaedaphne calyculata*

Shrub layer: *Chamaedaphne calyculata, Myrica gale, Ledum groenlandicum, Picea mariana, Thuja occidentalis, Betula papyrifera, Pinus strobus, Vaccinium angustifolium, Kalmia polifolia, Andromeda glaucophylla.*

Herb/Moss : *Scirpus* spp., *Sarracenia purpurea, Sphagnum fuscum, Sphagnum papillosum, Sphagnum rubellum.*

Soils : $>$ 120 cm mainly Oh; pH - 3.8

Slope

Position : Open Bog (Poor Fen?) adjacent to upper lake. Surface runoff each spring from surrounding mineral terrain.

## 7.0 SUMMARY

This study set out to define the biophysical conditions and ecological relationships in the Turkey Lakes watershed in terms of their existing vegetation, soil and site characteristics. This information is to provide baseline data for further research and to improve our understanding of the complex interactions between incident acid precipitation and various components of the forest ecosystem. The results, obtained through intensive field sampling and computer assisted analysis using the Cornell Ecological Programs, TWINSPAN and DECORANA, demonstrate novel uses of the two programs and their applicability for defining and classifying soil types and "map unit types" - areas of similar ecological characteristics. Detailed data on vegetation, soil and site conditions were collected and analyzed, yielding 17 unique association of various vegetation species and 9 unique soil types. Further analysis indicated a correlation between vegetation types and soil-elevation-slope positions, but found poor correlation between soil type and slope-elevation. Vegetation and soil types are not deterministically associated, though some trends were evident. Finally, a map of the Turkey Lakes watershed at a scale of 1:12 000 was produced to show areas of similar vegetation, soil and site characteristics.

The information generated by this study is providing valuable input into associated LRTAP projects within the Turkey Lakes watershed. The ecological map of vegetation-soil-site association is providing a framework for monitoring the effects of acid precipitation on forest productivity. The comprehensive baseline data set is also being utilized in groundwater hydrological studies, and serves as a benchmark of ecological conditions within the watershed on which future comparative studies with the four other federal calibrated watersheds can be made. Extrapolations of the methodologies and findings to similar areas within Ontario may be possible to improve our overall understanding of acid precipitation effects.

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# FOREST ECOSYSTEM CLASSIFICATION
# TURKEY LAKES WATERSHED ALGOMA DISTRICT

## LEGEND FOR THE MAP UNIT TYPES IN THE TURKEY LAKES WATERSHED

NOTE:

A MAP UNIT TYPE REPRESENTS A COMMONLY RECURRING LANDSCAPE PATTERN (OR ASSOCIATION) OF VEGETATION AND SOIL TYPES AS RECOGNIZED ON 1:15,840 SCALE BLACK AND WHITE AERIAL PHOTOGRAPHS.

| | *Map Unit Type Symbol* | *Map Unit Type Name* | *Area Occupied by Map Unit Type* | Dominant Vegetation Type(s). [Other Frequently Occurring Types] | Dominant Soil Type(s). [Other Frequently Occurring Types] |
|---|---|---|---|---|---|
| Upland Ecological Map Types | Ba | Batchawana | 18 ha 2% | V2; V11. [$V6_1$; V8; V5] | S1. [S2; S3; S4; S5; S9 (shallow soil)] |
| | Al | Algoma | 253 ha 23% | $V6_1$; $V6_2$. [$V6_3$] | S1; S3; S4; S5. |
| | Ti | Tilly | 141 ha 13% | $V6_1$ | S5 [S3; S4]. |
| | Su | Superior | 140 ha 13% | $V6_1$; V11 [V10; V3; $V9_1$] | S3; S5. [S4]. |
| | Ch | Chippewa | 307 ha 28% | $V6_1$; V11; $V9_1$; $V6_4$. | S4; S5. [S8; S9] |
| | Gr | Griffin | 78ha 7% | $V9_1$; $V6_1$. [$V6_3$; $V6_4$] | S4; S5 [S3; S7] |
| | No | Norberg | 14 ha 1% | $V9_2$ | S5 [S2; S6] |
| | Wi | Wishert | 76 ha 7% | V11 | S4 [S1] |
| Wetland Ecological Unit Map Type | 01 | Olsen | 63 ha 6% | . Open fen and bog. [Sedges/low shrubs] . Mixedwood with Sphagnum moss | S6 [Peaty phase mineral] |

### SOIL TYPES

| | | | |
|---|---|---|---|
| S1 | SANDY LOAM (LOAM-SILT LOAM) SANDY LOAM | S6 | ORGANIC |
| S2 | SILT LOAM (LOAM) SANDY LOAM-SILT LOAM | S7 | SANDY CLAY LOAM-CLAY LOAM CLAY LOAM-SAND |
| S3 | LOAMY SAND (SAND)-SILT LOAM SAND-SILT LOAM | S8 | SILTY CLAY LOAM/SAND |
| S4 | LOAM-SILT LOAM-SILT LOAM | S9 | SHALLOW SOIL-BOUNDARY |
| S5 | SILT LOAM SILT LOAM | | |

### VEGETATION TYPES

### RELIABILITY OF MAP:

THE MAP UNIT LEGEND FORMAT IS BASED ON INTENSIVE FIELD SAMPLING IN 51 POLYGONS. OTHER POLYGONS HAVE BEEN ASSIGNED ON THE BASIS OF INTERPRETATION OF 1:15,840 SCALE BLACK AND WHITE AERIAL PHOTOGRAPHS. POLYGONS WHICH HAVE BEEN FIELD SAMPLED AND FOR WHICH A HIGH RELIABILITY FACTOR IS EXPRESSED INCLUDE: 1, 4, 5, 6, 7, 14, 16, 20, 24, 28, 29, 31, 32, 34, 36, 37, 40, 41, 45, 46, 47, 48, 49, 54, 55, 59, 60, 61, 62, 65, 66, 67, 69, 70, 74, 75, 76, 77, 78, 84, 85, 86, 87, 90, 97, 99, 103, 107, 108, 109 AND 116.


MAP LEGEND

POLYGON NUMBER 67 — STUDY BOUNDARY — MAP UNIT Ch — POLYGON BOUNDARY — POLYGON AREA 16 ha — ROAD

SCALE

0 500 1000

METRES

**Figure 9 To Accompany Report Entitled "Forest Ecosystem Classification Of The Turkey Lakes Watershed, Ontario"**

**By G.M. Wickware and D.W. Cowell (1985).**


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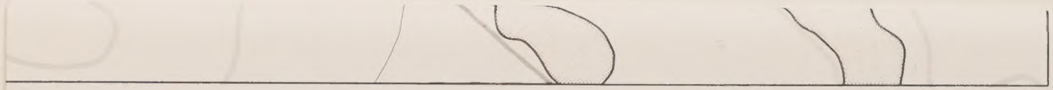

POLYGON AREA 16 ha

ROAD